

**SCOPE MATRIX FOR PHASE 1 TEMPLE MAIN HOPSITAL
RENOVATIONS - ICU & CATH LAB - 20250625**

SCOPE ITEM		DISCIPLINE					
		GENERAL CONTRACTOR	MECHANICAL	PLUMBING/FP/ SPRINKLER	ELECTRICAL/ TECHNOLOGY	TEMPLE	NOTES
1	GENERAL BUILDING PERMIT & FEES					X	
2	TRADE SPECIFIC PERMITS & FEES	X	X	X	X		INCLUDING STREET CLOSURES.
3	OVERALL SCHEDULE MANAGEMENT	X					
4	PARTICIPATION IN SCHEDULE COORDINATION	X	X	X	X		
5	SITE LOGISTICS COORDINATION	X					
6	DELIVERY COORDINATION	X					
7	SITE SECURITY	X					
8	SITE SPECIFIC SAFETY PROGRAM MANAGEMENT	X					
9	SITE LAYOUT AND CONTROL SURVEY	X	X	X	X		
10	TRAFFIC CONTROL FOR DELIVERIES	X	X	X	X		
11	CERTIFIED FLAGMEN FOR DELIVERIES	X	X	X	X		
12	CRANES & HOSTING	X	X	X	X		
13	CLEAN UP TO DUMPSTER	X	X	X	X		
14	PROVIDE DUMPSTERS	X					
15	HOISTING BEAMS AND MISC MATERIALS	X					
16	DE-ENERGIZING AND RE-ENERGIZING BUILDING SYSTEMS	X				X	
17	PERMANENT CORES DOOR HARDWARE	X				X	
18	FURNITURE, FIXTURES & EQUIPMENT UNLESS OTHERWISE NOTED	X				X	
19	TEMP TOILETS FOR ALL WORKERS ON SITE	X					
20	JOB SITE TRAILER FOR UTILITY CONNECTIONS & USAGE COSTS	X	X	X	X		
21	HOST WEEKLY COORDINATION MEETINGS	X					
22	MEETING MINUTES FOR WEEKLY COORDINATION MEETINGS	X					
23	ATTENDANCE AT WEEKLY COORDINATION MEETINGS	X	X	X	X	X	
24	WEB BASED FILE MANAGEMENT SYSTEM PARTICIPATION	X	X	X	X		
25	QUALITY CONTROL PROGRAM	X	X	X	X		
26	CERTIFIED PAYROLLS SUBMITTED ON A WEEKLY BASIS	X	X	X	X		
27	EOP PROGRAM VENDOR TRACKING INFORMATION ON MONTHLY BASIS	X	X	X	X		
GENERAL CONTRACTOR SCOPE							
29	SALVAGE STORAGE OF EQUIPMENT	X					
30	SALVAGE STORAGE OF CONSTRUCTION REINSTALLED	X					
31	INSTALLATION OF TEMP. CONSTRUCTION ENTRANCES AND ICRA PROTECTION	X					
32	CLEANING AND REMOVAL OF TEMPORARY CONSTRUCTION ENTRANCES AND ICRA PROTECTION	X					
33	COORDINATION AND DEMOLITION OF CONCRETE SLAB, PIPING AND BREECHING	X					
34	REMOVAL OF BUILDING ENVELOPE AND OTHER STRUCTURES TO BRING MATERIAL TO SITE AND COMPLETE INSTALLATION	X					
35	COORDINATE AND ISSUE SUBCONTRACT LIST, INCLUDING KEY PERSONNELCONTRACTOR'S CONSTRUCTION SCHEDULE AND DAILY CONSTRUCTION REPORTS	X					
36	CONSTRUCTION PROGRESS DIGITAL PHOTOGRAPHS	X					
37	ICRA-TEMPORARY CONSTRUCTION-PARTITIONS DOOR FRAMES AND MATERIALS	X					
38	ICRA TEMPORARY CONSTRUCTION-ELECTRICAL AND CARD ACCESS	X					
39	ICRA AIR FILTRATION UNITS, AIR HOSES, FILTERS	X					
40	ICRA DUCT DISINFECTION	X					
41	HEPA VACUUM	X					
42	SECURITY TEMPORARY CONSTRUCTION-ELECTRICAL AND CARD ACCESS	X					
43	TEMPORARY FIRE EXTINGUISHERS	X					
44	DEMOLITION CUTTING AND PATCHING	X					
45	REMOVAL OF SPOILS	X					
46	ROOF PROTECTION	X					
47	WELDING AND TESTING CERTIFICATES	X					
48	ACCESS PANELS INSTALLATION	X					
CLOSEOUT							

50	CONTRACTOR'S LIST OF INCOMPLETE ITEMS	X	X	X	X		
51	CERTIFIED LIST OF INCOMPLETE ITEMS	X					
52	CERTIFICATE OF INSURANCE	X	X	X	X		
53	FIELD REPORTS	X					
54	SCHEDULE OF MAINTENANCE MATERIALS ITEMS	X					
55	FINAL CLEANING	X					
56	RECORD DRAWING SUBMITTAL AND PRODUCT DATA	X					
57	DEMONSTRATIONS AND TRAINING-INSTRUCTIONAL PROGRAMS AND EVALUATION	X					
58	DEMOLITION PHOTOS	X					
59	DEMOLITION INVENTORY OF ITEMS SALVAGED	X					
60	METAL FABRICATIONS	X					
61	ROUGH CARPENTRY PRODUCT DATA	X					
62	ELECTRICAL DEVICES CUTOUTS AND EQUIPMENT DEVICES BACKING AND SUPPORTS	X					
63	PENETRATION FIRESTOPPING PRODUCT DATA	X					
64	PENETRATION FIRESTOPPING AND FILL MATERIAL INSTALLATION	X					
65	JOINT FIRESTOPPING PRODUCT DATA & CERTIFICATES	X					
66	JOINT FIRESTOPPING INSTALLATION	X					

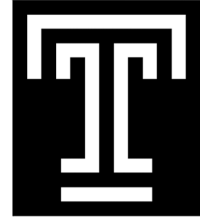
SCOPE ITEM	DISCIPLINE					
	GENERAL CONTRACTOR	MECHANICAL	PLUMBING/FP/SPRINKLER	ELECTRICAL/TECHNOLOGY	TEMPLE	NOTES
MECHANICAL SCOPE						
2 All work detailed by Division 23 specifications and on mechanical drawings including responsibility to coordinate work with all other trades	X	X	X	X	X	
3 All labor and materials to complete the work in accordance with the specifications and applicable codes		X				
4 Provide temporary heating, cooling, ventilation and dehumidification during construction		X				
5 Disposal of existing piping, complete cleaning		X				
6 Disposal of existing ductwork, complete cleaning		X				
7 Removing and re-installing existing equipment		X				
8 Coordination for all mechanical utility shutdowns	X	X	X	X	X	
9 Coordination for relocating existing ductwork with new mechanical ductwork		X				
10 Coordination for relocating existing mechanical piping with new mechanical piping		X				
11 Coordination of removal of all ceiling mounted devices required for scope of work		X				
Protect filter media, all return ducts, air handling equipment, outside air plenums/louvers, and return registers during construction		X				
13 Routing of new mechanical systems		X				
14 Coordinate electrical power connections		X		X		
15 Coordinate condensate drainage to floor drains and safety waste receptors.		X	X			
16 Installation of all ceiling mounted devices required for scope of work. Coordinate with other trades	X	X	X	X		
17 Coordinate concrete housekeeping pad installation with concrete contractor.	X	X				
18 Supply wall sleeves to concrete and/or masonry contractor		X				
19 Coordinate above ceiling MEP rough-in.	X	X				
20 Coordinate connection of motorized dampers for post event smoke purge system with GC and Temple Facilities. Dampers powered with low voltage power. Connect dampers back to existing post event smoke purge system	X	X			X	
21 Coordinate relocation of pneumatic tube to allow space for new air handling unit. Coordinate with GC and Temple to have Temple contract work to a delegated design team for relocated pneumatic tube	X	X			X	
22 Installation of new ductwork and mechanical piping including all dampers, fittings, vents, valves, and accessories		X				
23 Installation of piping for steam, steam condensate, and pumped condensate piping and piping connections		X				
24 Installation of all chilled water piping and piping connections		X				
25 Providing and installing all new HVAC equipment - custom air handling unit, return fan, exhaust fans, bag-in/bag-out filter housing assemblies, pumps, dampers, electric radiant ceiling panels, electric baseboard heaters, supply air terminal units with hot water reheat, return air terminal units, sound attenuators, grilles, registers, diffusers, ductless mini-split system(s), and miscellaneous equipment.		X				
26 Provide variable frequency drives (VFDs)		X		X		
27 Provide filters for all equipment including for air handling unit and bag-in/bag-out filter assembly filters		X				
28 Providing all scheduled options and accessories for equipment unless explicitly stated as provided by another contractor. If stated as provided by another contractor, mechanical contractor to coordinate with that contractor.		X				
29 All HVAC sheet metal ductwork and flexible connectors		X				
30 Provide steel or concrete inertia bases related to equipment provided by this bid package		X				
31 HVAC system components that are to be installed in the ductwork including but not limited to reheat coils, motorized actuators, controllers, sampling tubes, etc.		X				
32 All inlet and outlet dampers connected to equipment		X				
33 All sheet metal drain pans including outlet penetration and nipple		X				
34 All sound attenuation and vibration isolation including support hanger isolation and sound dampening insulation on equipment		X				
35 All sound attenuation associated with sheet metal ductwork supports		X				
36 Insulation of all equipment and distribution piping		X				
37 All ductwork insulation		X				
38 All volume dampers		X				
39 Locate valves, junction boxes, and other accessible items above accessible ceilings to the greatest extent possible to avoid the need for access panels		X				
40 Roof curbs for equipment		X				

41	Firestopping and sealants of all penetrations through partitions and slabs. Coordinate with all other trades	X	X	X	X		
42	Duct smoke detectors, fire dampers, smoke dampers, and combination fire and smoke dampers		X		X		
43	All exhaust, flues and vents from HVAC and plumbing equipment		X	X			
44	All ductwork access doors		X				
45	All hangers, steel support angles, vibration isolators, penetration sealant, firestopping, for all duct systems		X				
46	Fabrication and installation of sheet metal ductwork installation. Coordinate with all prime contractors	X	X	X	X		
47	All exterior ductwork, curbs, equipment support, insulation, vapor barrier jacket system, wall penetration and roof penetration flashing, and accessories		X				
48	All connections to exterior louvers. Include cutting blank off panels at duct connection. Exterior louvers, including birdscreens within the ductwork.		X				
49	All mesh screens and bird screens within the ductwork						
50	Final connection and termination of all ductwork to all HVAC equipment		X				
51	All BMS sensors, controls, equipment, conduit, wiring, terminations, and testing. Tie BMS system into all equipment provided by others as required. Coordinate BMS requirements with all other Prime Contractors.	X	X	X	X		
52	Power connections to BMS control panels.		X		X		
53	Installation of controls including metering devices and tie-in to building automation system for control and monitoring		X		X		
54	Testing and balancing (TAB) work.		X				
55	Start up, HVAC commissioning, testing, training and O&M Manuals		X		X		
56	Sheet metal drawings		X				
57	Shop drawings and submittals		X				
58							

SCOPE ITEM		DISCIPLINE					
		GENERAL CONTRACTOR	MECHANICAL	PLUMBING/FP/SPRINKLER	ELECTRICAL/TECHNOLOGY	TEMPLE	NOTES
PLUMBING/FIRE PROTECTION/SPRINKLER SCOPE							
	FIRE PROTECTION						
1	Delivery and storage of materials and equipment on site or in an acceptable off site storage location.	X		X			
2	Coordination with other trades for storage of materials and equipment on site.	X	X	X	X		
3	Responsibility of proper care and protection of project material and equipment.	X		X			
4	Fire protection demolition of existing sprinklers, branch piping and appurtenances related to the project area.			X			
5	Incidental demolition and rework of fire protection system in the 2nd floor plenum space to facilitate installation of MEP systems.			X			
6	De-energizing/ draining existing sprinkler system					X	
7	Removal of demolition debris associated with the fire protection systems demolished as part of this project.	X		X			
8	Temporary fire protection during demolition and construction phases.	X		X			
9	Delegated design of fire protection system.			X			
10	Obtain client fire pump system test information for use in hydraulic calculations.			X		X	
11	Fire protection system hydraulic calculations and drawings for fire marshal approval			X			
12	Low point drains in fire protection sprinkler supply piping.			X			
13	Coordination of sprinkler installation with electrical, mechanical and architectural ceiling conditions	X	X	X	X		
14	Examination of existing system valves and appurtenances to confirm proper operation.			X			
15	Furnishing and installation of required piping, valves, sprinklers and appurtenances.			X			
16	Piping supports for fire protection system piping.			X			
17	Fire Sealing of penetrations through fire rated walls.			X			
18	Sprinklers located in the center of ceiling tiles.			X			
19	coordination of alarm wiring with the fire alarm contractor as required.			X	X		
20	Fire Protection construction permits, required testing and inspector visit coordination.			X			
21	Pre-testing of installed piping to ensure leak-free construction.			X			
	PLUMBING						
1	Delivery and storage of materials and equipment on site or in an acceptable off site storage location.	X		X			
2	Coordination with other trades for storage of materials and equipment on site.	X	X	X	X		
3	Responsibility of proper care and protection of project material and equipment.	X		X			
4	Plumbing demolition of medical gas piping, acid waste piping, acid vent piping, sanitary piping, sanitary vent piping, storm piping, domestic water piping, plumbing fixtures, medical gas equipment and appurtenances related to the noted systems.			X			
5	Removal of demolition debris associated with the plumbing systems demolished as part of this project.	X		X			
6	Patching of existing floor penetrations that are not required for the new plumbing work.			X			
7	Temporary storm water system piping and temporary sanitary system piping as required to maintain operation of the systems during demolition and construction.			X			
8	Temporary plumbing services to supply temporary space conditioning equipment in coordination with the HVAC contractor.		X	X			
9	Temporary water service for contractor use during construction.	X		X			
10	Phased demolition and installation of the medical vacuum pump system			X			
11	Furnishing and installation of medical gas piping, acid waste piping, acid vent piping, sanitary piping, sanitary vent piping, storm piping, domestic water piping, plumbing fixtures, medical gas equipment and appurtenances related to the noted systems.			X			
12	All final connection of plumbing services to plumbing fixtures, plumbing equipment and the equipment of other trades that require plumbing services.		X	X			
13	Piping insulation on water systems and drainage systems specified for insulation.			X			
14	Access panels and coordination of panel location in conjunction with the architectural design and the valve locations.	X		X			
15	saw cutting and/or cores for through floor penetrations	X		X			
16	coordination of the installation of ADA grab bars	X		X			
17	Wiring and power to plumbing equipment			X	X		
18	Furnishing transformers and low voltage wiring for sensor faucets and flush valves			X	X		
19	Med Voltage wiring to transformers for sensor faucets and flush valves			X	X		

20	Coordination of mechanical condensate drains with drain location.		X	X			
21	Plumbing construction permits, required testing and inspector visit coordination.			X			
22	Piping supports for plumbing system piping.			X			
23	Fire proofing of floor and wall penetrations through fire rated elements.			X			
24	Commisioning of plumbing systems in the plumbing scope.			X			
25	Provide required training for staff for plumbing and medical gas systems installed as part of this project.			X			
26	Provide O&Ms for equipment installed within the project scope.			X			

SCOPE ITEM	DISCIPLINE					
	GENERAL CONTRACTOR	MECHANICAL	PLUMBING/FP/SPRINKLER	ELECTRICAL/TECHNOLOGY	TEMPLE	NOTES
ELECTRICAL/TECHNOLOGY SCOPE						
2 DEMOLITION OF SELECT EQUIPMENT				X		
3 SECURING OF ELECTRICAL SYSTEM FROM MECHANICAL AND PLUMBING EQUIPMENT BEING REMOVED	X	X	X	X		
4 TEMPORARY WIRING AS NEEDED TO MAINTAIN SYSTEMS DURING WORK				X		
5 INSTALLATION OF RELOCATED PANELS, BREAKERS, CIRCUITS, CONDUIT AND WIRING, STARTERS, DISCONNECTS, AND CONTROLS				X		
6 INSTALLATION OF NEW PANELS, BREAKERS, CIRCUITS, CONDUIT AND WIRING, STARTERS, DISCONNECTS, AND CONTROLS				X		
7 INSTALLATION OF NEW ELECTRICAL EQUIPMENT AND DEVICES SUCH AS LIGHTING FIXTURES, RECEPTACLES, ETC.				X		
8 INSTALLATION OF NEW FIRE ALARM EQUIPMENT AND DEVICES SUCH AS SMOKE DETECTORS, PULL BOXES, ETC.				X		
9 INSTALLATION OF NEW TECHNOLOGY EQUIPMENT AND DEVICES SUCH AS DATA OUTLETS, CARD READERS, ETC.				X		
10 INSTALLATION OF NEW NURSE CALL EQUIPMENT AND DEVICES SUCH AS PULL CORDS, STAFF STATIONS, ETC.				X		
11 START-UP, COMMISSIONING, TESTING, TRAINING, AND O&M MANUALS				X		
12 RELOCATION AND EXTENSION OF EXISTING WIRE AND CONDUIT AS REQUIRED TO FEED EXISTING EQUIPMENT ON OTHER FLOORS	X			X		
13 RELOCATION AND EXTENSION OF EXISTING WIRE AND CONDUIT AS REQUIRED FOR NEW MECHANICAL AND PLUMBING WORK	X			X		
14 RELOCATION AND EXTENSION OF EXISTING WIRE AND CONDUIT AS REQUIRED FOR NEW ELECTRICAL, SYSTEMS, AND TECHNOLOGY WORK	X			X		
15 COORDINATION WITH ALL OTHER CONTRACTORS FOR FINAL LOCATIONS AND REQUIREMENTS OF ALL POWERED EQUIPMENT	X	X	X	X		
16 CONFIRMATION OF EQUIPMENT NAMEPLATE DATA FROM OTHER CONTRACTORS PRIOR TO INSTALLING EQUIPMENT FEEDERS	X	X	X	X		
17 INTEGRATION OF NEW FIRE ALARM, TECHNOLOGY, AND NURSE CALL DEVICES INTO EXISTING SYSTEMS				X		
18 INSTALLATION OF ALL REQUIRED SUPPORTS AND FITTINGS FOR RACEWAYS				X		
19 DIVISION 26 AND DIVISION 28 SHOP DRAWINGS				X		
20 COORDINATION OF RACEWAY ROUTING WITH EXISTING AND NEW OBSTRUCTIONS	X			X		
21 RELOCATION OF POWER, SYSTEMS, AND TECHNOLOGY DEVICES AND EQUIPMENT AS REQUIRED TO COMPLETE WORK	X			X		
22 REMOVAL AND REINSTALLATION OF POWER, SYSTEMS, AND TECHNOLOGY DEVICES AND EQUIPMENT AS REQUIRED TO COMPLETE WORK	X			X		
23 COORDINATION OF POWER, SYSTEMS, AND TECHNOLOGY SHUTDOWNS WITH OWNER	X			X		
24 FIRESTOPPING OF ELECTRICAL PENETRATIONS	X					
25 INSTALLATION OF ALL REQUIRED JUNCTION BOXES				X		
26 LOAD STUDIES OF EXISTING ELECTRICAL EQUIPMENT				X		
27 COORDINATION STUDIES				X		
28 CORE DRILLING OF NEW CONDUIT	X					
29 INSTALLATION OF NEW FLOOR BOXES	X			X		
30 INSTALLATION OF TEMPORARY POWER AND LIGHTING				X		
31 PATCH AND REPAIR SURFACES DAMAGED BY INSTALLATION/REMOVAL OF TEMPORARY POWER AND LIGHTING				X		
32 REMOVAL OF TEMPORARY POWER AND LIGHTING				X		



Project Manual

**TEMPLE UNIVERSITY
HOSPITAL**

ANCILLARY BLD – Cath Lab 3

3401 North Broad Street

Philadelphia, PA 19140

Bidding Set

June 25, 2025

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SECTION 05 4000.C - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cold-formed metal framing for the following applications:
 - 1. Exterior non-load-bearing wall framing.
 - 2. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.
- B. Related Requirements:
 - 1. Section 09 2216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Sealed by the Professional Engineer responsible for their creation and registered in the State of Texas.
 - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
 - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
 - 3. Shop drawings shall be fully coordinated with supporting structural steel and masonry construction, and with curtain wall, storefront, window, and door elements supported by the cold formed metal framing.

1.4 INFORMATIONAL SUBMITTALS

- A. Structural Calculations: For information only; calculations sealed by the Professional Engineer responsible for their creation and registered in the State of Texas, indicating compliance with specified performance requirements.
- B. Qualification Data: For testing agency.

- C. Welding certificates.
- D. Product Certificates: For each type of code-compliance certification for studs and tracks.
- E. Product Test Reports: For each listed product, from a qualified testing agency.
 - 1. Steel sheet.
 - 2. Expansion anchors.
 - 3. Mechanical fasteners.
 - 4. Vertical deflection clips.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide products by one of the following:
 - 1. CEMCO, www.cemcosteel.com.
 - 2. ClarkDietrich Metal Framing; www.clarkdietrich.com.
 - 3. MarinoWare; www.marinoware.com.
 - 4. SCAFCO Corporation; www.scafco.com.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design cold-formed steel framing.

- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
1. Design Loads: As indicated on Drawings.
 2. Design exterior non-load-bearing wall framing to withstand design loads without horizontal deflections greater than $1/600$ for walls with masonry, stone, or plaster finishes, and $1/360$ for walls with other finishes.
 3. Design interior non-load-bearing wall framing to withstand a horizontal load of 5 lbs/sq ft without deflections greater than $1/240$ for walls with gypsum board finishes, and $1/360$ for walls with tile, stone, or plaster finishes.
 4. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
 5. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
 - a. Upward and downward movement of $1/300$.
 6. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
1. Wall Studs: AISI S211.
 2. Headers: AISI S212.
 3. Lateral Design: AISI S213.
- D. Fire-Resistance Ratings: Where metal framing is a part of a fire rated assembly, comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003, Structural Grade, Type H, metallic coated, Grade ST33H; or ASTM A653, Grade 33, unless higher grade is required to meet performance requirements.
1. Coating: G90.

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0538 inch (16 gage), unless greater thickness is required to meet performance criteria.
 - 2. Flange Width: 1-5/8 inches
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
 - 2. Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips as required to meet design conditions, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0538 inch (16 gage).
 - 2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch (20 gage).
 - 2. Flange Width: 1-3/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
 - 1. Minimum Base-Metal Thickness: Matching steel studs.
 - 2. Flange Width: 1-1/4 inches.
- C. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
 - 1. Minimum Base-Metal Thickness: 0.0329 inch (20 gage).
 - 2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.

2.6 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from same type, grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 - 1. Supplementary framing.
 - 2. Bracing, bridging, and solid blocking.
 - 3. Web stiffeners.
 - 4. End clips.
 - 5. Gusset plates.
 - 6. Stud kickers and knee braces.
 - 7. Hole-reinforcing plates.
 - 8. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36, zinc coated by hot-dip process according to ASTM A123.
- B. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.
 - 1. Uses: Securing cold-formed steel framing to structure.
 - 2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
 - 3. Material for Exterior Locations: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.
- C. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- D. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780, MIL-P-21035B or SSPC-Paint 20.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- B. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed steel framing members by welding or screw fastening. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- C. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- D. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

- E. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- F. Install insulation, specified in Section 07 2100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- G. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to bottom track unless otherwise indicated. Space studs as indicated on Shop Drawings, but not greater than 16 inches oc.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
 - 2. Connect vertical deflection clips to bypassing and infill studs and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings. Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Unless indicated otherwise on Shop Drawings, install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to bottom track unless otherwise indicated. Space studs as follows:
 - 1. Stud Spacing: As indicated on Drawings, but not greater than 16 inches oc.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 - 1. Install single deep-leg deflection tracks and anchor to building structure.
- E. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track.
- F. Install horizontal bridging where indicated on Drawings
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 ERECTION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.7 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 064023.C - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Rooftop equipment bases and support curbs.
 - 2. Wood blocking, cants, and nailers.
 - 3. Wood furring and grounds.
 - 4. Plywood backing panels.
 - 5. Fasteners for attaching any device, equipment signage, decoration, or other wall-mounted accessory to gypsum board wall construction.

1.3 DEFINITIONS

- A. Lumber grading agencies, and the abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NHLA: National Hardwood Lumber Association.
 - 3. NLGA: National Lumber Grades Authority.
 - 4. SPIB: The Southern Pine Inspection Bureau.
 - 5. WCLIB: West Coast Lumber Inspection Bureau.
 - 6. WWPA: Western Wood Products Association.
- B. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise specified. All rough carpentry materials incorporated into this Project are to be fire-retardant-treated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with

requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, showing compliance with building code in effect for the project:
1. Preservative-treated wood.
 2. Fire-retardant-treated wood.
 3. Metal framing anchors.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated and acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack materials on treated or non-decaying skids sized and arranged as to support the material without producing noticeable distortion and to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.
- B. Storage areas shall be free of debris, decayed wood, and vegetation and shall have sufficient drainage to prevent treated wood products from contact with standing water.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber with each

piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.

1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 4. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber: 19 percent maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
 2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
- D. Application: Treat items indicated on Drawings, and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

4. Wood framing members that are less than 18 inches above the ground in crawl spaces or unexcavated areas.
 5. Wood floor plates that are installed over concrete slabs-on-grade.
- E. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Arch Wood Protection, Inc.
 2. Hoover Treated Wood Products, Inc.
 3. Osmose Wood Preserving, Inc.
 4. Universal Forest Products.
 5. Viance.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: All rough carpentry materials shall be fire-retardant-treated wood and shall comply with applicable requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection Inc., or another testing and inspecting agency acceptable to authorities having jurisdiction.
1. Research or Evaluation Reports: Provide fire-retardant-treated wood acceptable to authorities having jurisdiction and for which a current model code research or evaluation report exists that evidences compliance of fire-retardant-treated wood for application indicated.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
1. Use treatment that does not promote corrosion of metal fasteners.
 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
 - a. Contact with treated wood does not promote corrosion of metal fasteners.
 - b. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) American Wood Treatment, Inc.
 - 2) Arch Wood Protection, Inc.
 - 3) Hoover Treated Wood Products, Inc.
 - 4) Universal Forest Products.
 - 5) Viance.

3. Interior Type A: For interior locations, use chemical formulation that produces treated lumber and plywood with the following properties under conditions present after installation:
 - a. Bending strength, stiffness, and fastener-holding capacities are not reduced below values published by manufacturer of chemical formulation under elevated temperature and humidity conditions simulating installed conditions when tested by a qualified independent testing agency.
 - b. No form of degradation occurs due to acid hydrolysis or other causes related to treatment.
 - c. Contact with treated wood does not promote corrosion of metal fasteners.
 - d. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Arch Wood Protection, Inc.
 - 2) Hoover Treated Wood Products, Inc.
 - 3) Universal Forest Products.
 - 4) Viance.
 - C. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
 1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
 - D. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
 - E. Application: Treat all miscellaneous carpentry including, but not limited to, the following, unless otherwise indicated:
 1. Framing for raised platforms.
 2. Concealed blocking.
 3. Roof framing and blocking.
 4. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
 5. Plywood backing panels.
- 2.4 DIMENSION LUMBER FRAMING
- A. General: Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.
 - B. Framing Other than Non-Load-Bearing Partitions: No. 2 grade and any of the following species:
 1. Douglas fir-larch; WCLIB or WWPA.

2. Mixed southern pine; SPIB.
 3. Douglas fir-south; WWPA.
 4. Hem-fir; WCLIB or WWPA.
- C. Ceilings (Non-Load-Bearing): For ceiling framing that does not support a floor, roof, or attic, provide No. 2 grade and any of the following species:
1. Douglas fir-larch; WCLIB or WWPA.
 2. Mixed southern pine; SPIB.
 3. Douglas fir-south; WWPA.
 4. Hem-fir; WCLIB or WWPA.

2.5 BOARDS

- A. Concealed Boards: Where boards will be concealed by other work, provide lumber with 19 percent maximum moisture content and of the following species and grade:
1. Species and Grade: Western woods, Standard per WCLIB rules or No. 3 Common per WWPA rules.

2.6 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
 2. Nailers.
 3. Rooftop equipment bases and support curbs.
 4. Cants.
 5. Furring.
 6. Grounds.
 7. Stripping.
- B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown on the Drawings.
- C. Moisture Content: 19 percent maximum for lumber items not specified to receive wood-preservative treatment.
- D. For items of dimension lumber size, provide Standard, or No. 3 grade lumber per ALSC's NGRs of any species.
- E. For board-size lumber, provide No. 3 Common grade per NELMA, NLGA, or WWPA; No. 2 grade per SPIB; or Standard grade per NLGA, WCLIB, or WWPA of any species.

2.7 PLYWOOD BACKING PANELS

- A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than **3/4-inch** nominal thickness.
 - 1. Plywood used on the interior of the building - defined as inside of the weatherproofing system - shall contain no added urea formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood assemblies shall contain no added urea formaldehyde resins.

2.8 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M of Type 304 stainless steel.
- B. Nails, Brads, and Staples: ASTM F 1667.
 - 1. For fastening lumber to lumber, provide cement-coated or annular (ringed-shank) threaded nails of sufficient length to penetrate a minimum of 1-1/4-inch into adjoining members, or stove or lag bolts used with washers.
 - 2. For fastening plywood to lumber, provide annular (ringed-shank) threaded nails; 8d for 1/2-inch-thick plywood and 10d for 3/4-inch-thick plywood.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: **ASME B18.2.1**.
- G. Bolts: Steel bolts complying with **ASTM A 307, Grade A**; with **ASTM A 563** hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

- I. Fasteners for Gypsum Wall Construction: For attaching any device, equipment signage, decoration, or other wall-mounted accessory to gypsum wall construction, provide one of the following:
 1. Single-Layer Gypsum Board Wall Construction:
 - a. “Molly” sleeve-type hollow wall anchors.
 - b. One-piece self-drilling anchors or nylon or alloy construction for light and medium loads such as ITW Buildex E-Z Anchor Self-Drilling Drywall Anchor.
 - c. Self-drilling single-point metal toggle for heavy duty loads such as ITW Buildex E-Z Toggle.
 2. Multiple-Layer Gypsum Board Wall Construction:
 - a. “Molly” sleeve-type hollow wall anchors.
 - b. Metal wing-type toggle bolts.

2.9 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
 1. All adhesives used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following requirements as applicable to the Project scope:
 - a. Adhesives must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168 effective date of July 1, 2005 and rule amendment date of January 7, 2005.
 - b. Aerosol adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.
 - c. Adhesives shall contain no carcinogen or reproductive toxicant components present at more than 1 percent of total mass of the product as defined in the California Office of Environmental Health Hazard Assessment’s (OEHHA) list entitled “Chemicals Known to the State to Cause Cancer” or the Reproductive Toxicity, Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65).
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than **0.025 inch**.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- C. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.
- D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven staples, P-nails, and allied fasteners.
 - 2. "Recommended Nailing Schedule" of referenced framing standard and with AFPA's "National Design Specifications for Wood Construction."
- E. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; pre-drill as required.
- F. Use hot-dip galvanized or stainless steel nails where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity.
- G. Countersink nail heads on exposed carpentry work and fill holes with wood filler.
- H. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- I. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.
- J. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- K. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block concealed spaces of wood-framed walls and partitions at each floor level and at ceiling line of top story. Where fire blocking is not inherent in

framing system used, provide closely fitted wood blocks of 2-inch nominal (38-mm actual) thickness lumber of same width as framing members.

- L. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- M. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- N. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. NES NER-272 for power-driven fasteners.
 - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
- O. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD FRAMING, GENERAL

- A. Framing Standard: Comply with AFPA's "Manual for Wood Frame Construction," unless otherwise indicated.
- B. Install framing members of size and at spacing indicated.
- C. Frame openings as indicated.
- D. Do not splice structural members between supports.

3.3 WALL AND PARTITION FRAMING

- A. General: Arrange studs so that wide face of stud is perpendicular to direction of wall or partition and narrow face is parallel. Provide single bottom plate and double top plates using members of 2-inch nominal thickness whose widths equal that of studs; except single top plate may be used for non-load-bearing partitions. Nail or anchor plates to supporting construction, unless otherwise indicated.
- B. Construct corners and intersections with 3 or more studs. Provide miscellaneous blocking and framing as shown and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide continuous horizontal blocking at mid-height of single-story partitions over 96 inches high and multistory partitions, using members of 2-inch nominal thickness and of same width as wall or partitions.
- C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Set headers on edge and support on jamb studs.
 1. For non-load-bearing partitions, provide double-jamb studs with headers not less than 4-inch nominal depth for openings 36 inches and less in width, and not less than 6-inch nominal depth for wider openings.

3.4 WOOD GROUND, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than **1-1/2 inches** wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.5 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install **1-by-3-inch nominal-size** furring horizontally or vertically at **24 inches** o.c.
- C. Furring to Receive Gypsum Board or Plaster Lath: Install **1-by-2-inch nominal-size** furring vertically at **16 inches** o.c.

3.6 INSTALLATION OF PLYWOOD BACKING PANELS

- A. Nail or screw plywood backing panels to supports.

3.7 INSTALLATION OF FASTENERS FOR WALL-MOUNTED ACCESSORIES TO GYPSUM WALL CONSTRUCTION

- A. Whenever possible, objects shall be mounted to gypsum board wall construction by aligning the fastening point at and into a supporting member (stud or channel), solid blocking (consisting of fire-retardant-treated wood blocking or metal grounds), or grounds in order to avoid the need for any form of thru-wall anchor.

- B. Where fastening to framing or blocking as described above is not possible, the following methods shall be used:
1. For concealed spaces or utility spaces not exposed to public view, attach fire-retardant-treated wood blocking or plywood backing on the face of the drywall to the metal studs or wall framing as described above, then attach the device or equipment to the backing.
 2. For exposed and finished areas exposed to public view, including patient room and procedure areas, use only approved types of wall anchors as specified. Only nylon or metal anchors of the types specified may be used. It is the installer's responsibility to select an anchor of appropriate type and capacity for the weight of the object and manner of attachment, and sized for the thickness of the gypsum board.
 3. Installation:
 - a. Single-Layer Gypsum Board Wall Construction:
 - 1) "Molly" Sleeve-Type Hollow Wall Anchors: Gypsum board wall construction must be drilled to accept this type of fastener; driving or hammering the fastener through the gypsum board is not permitted.
 - 2) One-Piece Self-Drilling Anchors or Nylon or Alloy Construction: This fastener is screwed into the wall construction, then receives a screw that expands the anchor in the gypsum board.
 - 3) Self-Drilling Single-Point Metal Toggle for Heavy Duty Loads: This fastener is screwed into the wall construction, and then received a screw that deploys the toggle element and draws it tight to the back of the wallboard.
 - b. Multiple-Layer Gypsum Board Wall Construction:
 - 1) "Molly" Sleeve-Type Hollow Wall Anchors: Gypsum board wall construction must be drilled to accept this type of fastener; driving or hammering the fastener through the gypsum board is not permitted.
 - 2) Metal Wing-Type Toggle Bolts: Gypsum board wall construction must be drilled to accept this type of fastener; driving or hammering the fastener through the gypsum board is not permitted. The hole must be filled with gypsum board compound or acrylic or silicone caulking; the bolt must be installed with a minimum 18 gage (0.048-inch) thick washer 1/8 inch diameter larger than the diameter of the drilled hole. Washer is to be situated directly against the face of the gypsum board.
 4. Do not exceed more than 30 fasteners penetrating the gypsum board in a 50 square foot area of fire-rated wall. For installations requiring a higher concentration of fasteners, contact the Owner for instruction prior to proceeding.
 - a. This criteria is not intended to limit a maximum of 1.66 fasteners per square foot, but is to limit the overall number of fasteners in a given area of wall.

3.8 PROTECTION

- A. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 064116.C - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets.
2. Cabinet hardware and accessories.
3. Miscellaneous materials.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.
2. Section 064112 "Wood Veneer Faced Architectural Cabinets"
3. Section 123623.16 "Solid Surface Countertops."

1.2 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.
- B. Hardware Coordination: Distribute copies of approved hardware schedule specified in to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.4 FIELD CONDITIONS

- A. Environmental Limitations without Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

- B. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.5 ACTION SUBMITTALS

- A. Product Data:
 - 1. Plastic-laminate-clad architectural cabinets.
 - 2. Cabinet hardware and accessories.
 - 3. Miscellaneous materials.
- B. Product Data Submittals: For each product.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Show large-scale details.
 - 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
- D. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.
- E. Samples for Initial Selection: For each type of exposed finish.
- F. Samples for Verification: For the following:

1. Plastic Laminates: 8 by 10 inches for each type, color, pattern, and surface finish required.
 - a. Provide one sample applied to core material with specified edge material applied to one edge.
2. Thermally Fused Laminate (TFL) Panels: 8 by 10 inches for each color, pattern, and surface finish.
 - a. Provide edge banding on one edge.
3. Corner Pieces:
 - a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
 - b. Miter joints for standing trim.
4. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.6 INFORMATION SUBMITTALS

- A. Qualification Data: For manufacturer and installer.
- B. Product Certificates: For each type of product.
- C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
- D. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Licensed participant in AWI's Quality Certification Program and Licensed participant in WT's Certified Compliance Program.

PART 2 - PRODUCTS

2.1 FABRICATION PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.
- B. Architectural Woodwork Standards Grade: Custom.

- C. Type of Construction: Frameless.
- D. Door and Drawer-Front Style: Flush.
- E. High-Pressure Decorative Laminate: ISO 4586-3, grades as indicated or if not indicated, as required by quality standard.
- F. Exposed Surfaces:
 - 1. Plastic Laminate Grade: As specified.
 - 2. Edges: PVC edge banding, 2.0 mm thick, exactly matching laminate in color, pattern, and finish
 - 3. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels UNO in drawings
- G. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. As selected by Architect from laminate manufacturer's full range. Refer to Interior Finish Material Legend.

2.2 WOOD MATERIALS

2.3 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Wood Moisture Content: 4 to 9 percent.
- B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
 - 1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
 - 2. Particleboard (Medium Density): ANSI A208.1, Grade M-2.
 - 3. Softwood Plywood: DOC PS 1, medium-density overlay.
 - 4. Thermally Fused Laminate (TFL) Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of ISO 4586.

2.4 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets except for items specified in Section 08 7100 "Door Hardware ."
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening, self-closing.
- C. Back-Mounted Pulls: BHMA A156.9, B02011.

- D. Catches: Roller catches, BHMA A156.9, B03071 or Ball friction catches, BHMA A156.9, B03013.
- E. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.
- F. Shelf Rests: BHMA A156.9, B04013; metal, two-pin type with shelf hold-down clip.
- G. Drawer Slides: BHMA A156.9.
 - 1. Grade 1: Side mounted and extending under bottom edge of drawer; full-extension type; epoxy-coated steel with polymer rollers.
 - 2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-over-travel-extension type; zinc-plated-steel ball-bearing slides.
 - 3. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 1.
 - 4. For drawers more than 3 inches high but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100.
 - 5. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-200.
 - 6. For computer keyboard shelves, provide Grade 1.
 - 7. For trash bins not more than 20 inches high and 16 inches wide, provide Grade 1HD-100.
 - 8. Features: Provide self-closing/stay closed and special finish epoxy finish type.
- H. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Satin Stainless Steel: BHMA 630.
- I. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.
- J. Metal Reveals: No. 304 Stainless steel with No. 4 finish; 16 gauge.
- K. Stainless Steel Materials:
 - 1. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
 - 2. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

2.5 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

- C. Adhesives: Do not use adhesives that contain urea formaldehyde. Type recommended by AWI/AWMAC to suit application.
- D. VOC Limits for Installation Adhesives: Use products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Wood Glues: 30 g/L.
 - 2. Multipurpose Construction Adhesives: 70 g/L.
 - 3. Contact Adhesive: 80 g/L.
 - 4. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.

2.6 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.
- B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 - 1. Notify Architect seven days in advance of the dates and times architectural cabinet fabrication will be complete.
 - 2. Trial fit assemblies at manufacturer's shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
- D. Install glass to comply with applicable requirements in Section 08 8000 "Glazing" and in GANA's "Glazing Manual."
 - 1. For glass in frames, secure glass with removable stops.
 - 2. For exposed glass edges, polish and grind smooth.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.
- B. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.
- C. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.
 - 1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
 - 2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

END OF SECTION

SECTION 070150.19.C - PREPARATION FOR RE-ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Partial roof tear-off.
 - 2. Temporary roofing membrane.
 - 3. Roof re-cover preparation.
 - 4. Removal of base flashings.
- B. Related Sections:
 - 1. Section 01 11 00 "Summary of Work" for use of the premises and phasing requirements.
 - 2. Section 01 50 00 "Temporary Facilities and Controls" for temporary construction and environmental-protection measures for reroofing preparation.

1.3 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.4 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
- B. Existing Roofing System: May be one of the following, including roof insulation, surfacing, and components and accessories between deck and roofing membrane.
 - 1. Built-up roofing.
 - 2. EPDM membrane.
 - 3. PVC membrane
 - 4. Slate with membrane underlayment.
 - 5. Liquid-applied membrane.
- C. Roof Re-Cover Preparation: Existing roofing membrane that is to remain and be prepared for reuse.
- D. Partial Roof Tear-Off: Removal of a portion of existing membrane roofing system from deck or removal of selected components and accessories from existing membrane roofing system.

- E. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and reinstalled.
- F. Existing to Remain: Existing items of construction that are not indicated to be removed.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Temporary Roofing: Include Product Data and description of temporary roofing system. If temporary roof will remain in place, submit surface preparation requirements needed to receive permanent roof, and submit a letter from roofing membrane manufacturer stating acceptance of the temporary membrane and that its inclusion will not adversely affect the roofing system's resistance to fire and wind.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer is approved by warrantor of existing roofing system.
- B. Fastener pull-out test report.
- C. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Installer of new membrane roofing system approved by warrantor of existing roofing system to work on existing roofing.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning membrane roofing removal. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Reroofing Conference: Conduct conference at Project site.
 - 1. Meet with Owner; Architect; Owner's insurer if applicable; testing and inspecting agency representative; roofing system manufacturer's representative; deck Installer; roofing Installer including project manager, superintendent, and foreman; and installers whose work interfaces with or affects reroofing including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing system tear-off and replacement including, but not limited to, the following:
 - a. Reroofing preparation, including membrane roofing system manufacturer's written instructions.
 - b. Temporary protection requirements for existing roofing system that is to remain during and after installation.
 - c. Existing roof drains and roof drainage during each stage of reroofing, and roof drain plugging and plug removal requirements.

- d. Construction schedule and availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- e. Existing deck removal procedures and Owner notifications.
- f. Condition and acceptance of existing roof deck and base flashing substrate for reuse.
- g. Structural loading limitations of deck during reroofing.
- h. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that will affect reroofing.
- i. HVAC shutdown and sealing of air intakes.
- j. Shutdown of fire-suppression, -protection, and -alarm and -detection systems.
- k. Governing regulations and requirements for insurance and certificates if applicable.
- l. Existing conditions that may require notification of Owner before proceeding.

1.8 PROJECT CONDITIONS

- A. Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so Owner's operations will not be disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.
 1. Coordinate work activities daily with Owner so Owner can place protective dust or water leakage covers over sensitive equipment or furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below the work area.
 2. Before working over structurally impaired areas of deck, notify Owner to evacuate occupants from below the affected area. Verify that occupants below the work area have been evacuated before proceeding with work over the impaired deck area.
- B. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
- C. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
- D. Conditions existing at time of inspection for bidding will be maintained by Owner as far as practical.
- E. Limit construction loads on roof for rooftop equipment wheel loads and for uniformly distributed loads to the limits agreed to in the Re-Roofing Conference.
- F. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
- G. Hazardous Materials: It is not expected that hazardous materials such as asbestos-containing materials will be encountered in the Work.
 1. Hazardous materials will be removed by Owner before start of the Work. Existing roof will be left no less watertight than before removal.
 2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Owner. Hazardous materials will be removed by Owner under a separate contract.

1.9 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty. Notify warrantor before proceeding.
 - 1. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.
 - 2. See existing roof warranty exhibit attached for reference

PART 2 - PRODUCTS

2.1 INFILL MATERIALS

- A. Use infill materials matching existing membrane roofing system materials unless otherwise indicated.

2.2 AUXILIARY REROOFING MATERIALS

- A. General: Auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing and new membrane roofing system.
- B. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FM Approval's "Approval Guide."
- C. Metal Flashing Sheet: Metal flashing sheet is specified in Section 07 62 00 "Sheet Metal Flashing and Trim."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect existing membrane roofing system that is indicated not to be reroofed.
 - 1. Loosely lay 1-inch- minimum thick, molded expanded polystyrene (MEPS) insulation over the roofing membrane in areas indicated. Loosely lay 15/32-inch plywood or OSB panels over MEPS. Extend MEPS past edges of plywood or OSB panels a minimum of 1 inch.
 - 2. Limit traffic and material storage to areas of existing roofing membrane that have been protected.
 - 3. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.
- B. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

- C. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.
- D. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.
 - 1. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing membrane roofing system components that are to remain.
- E. Verify that rooftop utilities and service piping have been shut off before beginning the Work.

3.2 ROOF TEAR-OFF

- A. General: Notify Owner each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.
- B. Remove aggregate ballast from roofing membrane. Store aggregate ballast for reuse.
 - 1. Do not store aggregate in corners or exceed roof capacity.
- C. Remove pavers and accessories from roofing membrane. Store and protect pavers and accessories for reuse. Discard cracked pavers.
- D. Partial Roof Tear-Off: Where indicated, remove existing roofing membrane and other membrane roofing system components down to the deck.
 - 1. Remove cover boards, roof insulation, and substrate boards.
 - 2. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
 - 3. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. of asphalt is permitted to remain on steel decks.
 - 4. Remove fasteners from deck.
- E. Partial Roof Tear-Off: Remove existing roofing membrane and immediately check for presence of moisture by visually observing cover boards, roof insulation, and substrate boards that will remain.
 - 1. Coordinate with Owner's inspector to schedule times for tests and inspections immediately after membrane removal.
 - 2. With an electrical capacitance moisture-detection meter, spot check cover boards, roof insulation, and substrate boards that will remain.
 - 3. Remove wet or damp boards and roof insulation.
 - 4. Bitumen and felts that are firmly bonded to concrete decks are permitted to remain if felts are dry. Remove unadhered bitumen and felts and wet felts.
 - 5. Remove excess asphalt from steel deck. A maximum of 15 lb/100 sq. ft. of asphalt is permitted to remain on steel decks.
 - 6. Remove fasteners from deck.

3.3 DECK PREPARATION

- A. Inspect deck after tear-off of membrane roofing system.
- B. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 or by pouring 1 pint of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under the plastic sheet or if asphalt test sample foams or can be easily and cleanly stripped after cooling.
- C. If broken or loose fasteners that secure deck panels to one another or to structure are observed or if deck appears or feels inadequately attached, immediately notify Owner. Do not proceed with installation until directed by Owner.
- D. If deck surface is not suitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Owner. Do not proceed with installation until directed by Owner.

3.4 INFILL MATERIALS INSTALLATION

- A. Immediately after removal of selected portions of existing membrane roofing system, and inspection and repair, if needed, of deck, fill in the tear-off areas to match existing membrane roofing system construction.
 - 1. Install new roofing membrane patch over roof infill area. If new roofing membrane is installed the same day tear-off is made, roofing membrane patch is not required.

3.5 TEMPORARY ROOFING MEMBRANE

- A. Install approved temporary roofing membrane over area to be reroofed.
- B. Remove temporary roofing membrane before installing new roofing membrane.

3.6 ROOF RE-COVER PREPARATION

- A. Remove blisters, ridges, buckles, and other substrate irregularities from existing roofing membrane that inhibit new recover boards from conforming to substrate.
 - 1. Broom clean existing substrate.
 - 2. Coordinate with Owner's inspector to schedule times for tests and inspections before proceeding with installation of recover boards.
 - 3. Verify that existing substrate is dry before proceeding with installation of recover boards. Spot check substrates with an electrical capacitance moisture-detection meter.
 - 4. Remove materials that are wet or damp.

3.7 EXISTING BASE FLASHINGS

- A. Remove existing base flashings around parapets, curbs, walls, and penetrations.
 - 1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.

- B. Do not damage metal counterflashings that are to remain. Replace metal counterflashings damaged during removal with counterflashings specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
- C. Inspect parapet sheathing for deterioration and damage. If parapet sheathing has deteriorated, immediately notify Owner.

3.8 FASTENER PULL-OUT TESTING

- A. Retain independent testing and inspecting agency to conduct fastener pull-out tests according to SPRI FX-1, and submit test report to Owner and roofing membrane manufacturer before installing new membrane roofing system.
 - 1. Obtain Owner's and roofing membrane manufacturer's approval to proceed with specified fastening pattern. Owner and roofing membrane manufacturer may furnish revised fastening pattern commensurate with pull-out test results.

3.9 DISPOSAL

- A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
 - 1. Storage or sale of demolished items or materials on-site is not permitted.
- B. Transport and legally dispose of demolished materials off Owner's property.

END OF SECTION 07 01 50.19

Ancillary Building Roofing Warranties



Single-Ply System

SERIAL NO. TS59737

DATE OF ISSUE: AUGUST 16, 2005

CARLISLE GOLDEN SEAL™ TOTAL ROOFING SYSTEM WARRANTY

BUILDING OWNER: TEMPLE UNIVERSITY HEALTH SYSTEMS
 NAME OF BUILDING: TEMPLE UNIV-ANCILLARE BLDG.NW CORNER
 BUILDING ADDRESS: PHILADELPHIA, PA
 DATE OF COMPLETION OF THE CARLISLE TOTAL ROOFING SYSTEM: 06/17/05
 DATE OF ACCEPTANCE BY CARLISLE: E B WARRANTY (08/16/05)

AB#050375L

Carlisle Roofing Systems, Inc., warrants to the Building Owner (OWNER) of the above described building, that, subject to the terms, conditions and limitations stated in this warranty, Carlisle will repair any leak in the Carlisle Golden Seal™ Total Roofing System (CARLISLE TOTAL ROOFING SYSTEM) installed by a Carlisle Authorized Roofing applicator for a period of 20 years commencing with the date of Carlisle's acceptance of the Carlisle Total Roofing System installation. However, in no event shall Carlisle's obligations extend beyond 20.5 years subsequent to the date of substantial completion of the Carlisle Total Roofing System. See below for exact date of warranty expiration. The Carlisle Total Roofing System is defined as the following Carlisle brand materials: Membrane, Flashings, Counterflashings, Adhesives and Sealants, Insulation, Recovery Board, Fasteners, Fastener Plates, Fastening Bars, Metal Edging, Metal Termination Bars, and any other Carlisle brand products utilized in this installation.

TERMS, CONDITIONS, LIMITATIONS

- Owner shall provide Carlisle with written notice within thirty (30) days of the discovery of any leak in the Carlisle Total Roofing System. Owner should send written notice of a leak to Carlisle's Warranty Services Department at the address set forth at the bottom of this warranty. By so notifying Carlisle, the Owner authorizes Carlisle or its designee to investigate the cause of the leak. Should the investigation reveal the cause of the leak to be outside the scope of this Warranty, investigation and repair costs for this service shall be paid by the Owner.
- If, upon inspection, Carlisle determines that the leak is caused by a defect in the Carlisle Total Roofing System's materials, or workmanship of the Carlisle Authorized Roofing Applicator in installing the same, Owner's remedies and Carlisle's liability shall be limited to Carlisle's repair of the leak.
- This warranty shall not be applicable if, upon Carlisle's inspection, Carlisle determines that any of the following has occurred:
 - The Carlisle Total Roofing System is damaged by natural disasters, including, but not limited to, lightning, fire, insect infestations, earthquake, tornado, hail, hurricanes, and winds of peak gust speeds of 80 mph or higher measured at 10 meters above ground; or
 - The Carlisle Total Roofing System is damaged by any intentional or negligent acts, accidents, misuse, abuse, vandalism, civil disobedience, or the like
 - Deterioration or failure of building components, including, but not limited to, the roof substrate, walls, mortar, HVAC units, non-Carlisle brand metal work, etc., occurs and causes a leak, or otherwise damages the Carlisle Total Roofing System; or
 - Acids, oils, harmful chemicals and the like come in contact with the Carlisle Total Roofing System and cause a leak, or otherwise damage the Carlisle Total Roofing System.
- This Warranty shall be null and void if any of the following shall occur:
 - if, after installation of the Carlisle Total Roofing System by a Carlisle Authorized Roofing Applicator there are any alterations or repairs made on or through the roof or objects such as, but not limited to, structures, fixtures, or utilities are placed upon or attached to the roof without first obtaining written authorization from Carlisle; or
 - Failure by the Owner to use reasonable care in maintaining the roof, said maintenance to include, but not be limited to, those items listed on Carlisle's Care & Maintenance information sheet which accompanies this Warranty.
- Only Carlisle brand insulation products are covered by this warranty. Carlisle specifically disclaims liability, under any theory of law, for damages sustained by or caused by non-Carlisle brand insulation products.
- During the term of this Warranty, Carlisle shall have free access to the roof during regular business hours.
- Carlisle shall have no obligation under this Warranty while any bills for installation, supplies, service, and warranty charges have not been paid in full to the Carlisle Authorized Roofing Applicator, Carlisle, or material suppliers.
- Carlisle's failure at any time to enforce any of the terms or conditions stated herein shall not be construed to be a waiver of such provision.
- Carlisle shall not be responsible for the cleanliness or discoloration of the Carlisle Total Roofing System caused by environmental conditions including, but not limited to, dirt, pollutants, or biological agents.
- Carlisle shall have no liability under any theory of law for any claims, repairs, restoration, or other damages including, but not limited to, consequential or incidental damages relating, directly or indirectly, to the presence of any irritants, contaminants, vapors, fumes, molds, fungi, bacteria, spores, mycotoxins, or the like in the building or in the air, land, or water serving the building.
- This warranty is not assignable by operation of law or otherwise. Application may be made by a new building owner for reissuance of the warranty during the original warranty period. Certain procedures including, but not limited to, an inspection of the Roofing System by a Carlisle representative and fees will apply to any reissuance. Carlisle reserves the right, in its sole discretion, to refuse to reissue this warranty.

CARLISLE DOES NOT WARRANT PRODUCTS UTILIZED IN THIS INSTALLATION WHICH IT HAS NOT FURNISHED; AND SPECIFICALLY DISCLAIMS LIABILITY, UNDER ANY THEORY OF LAW, ARISING OUT OF THE INSTALLATION AND PERFORMANCE OF, OR DAMAGES SUSTAINED BY OR CAUSED BY, PRODUCTS NOT FURNISHED BY CARLISLE.

THE REMEDIES STATED HEREIN ARE THE SOLE AND EXCLUSIVE REMEDIES FOR FAILURE OF THE CARLISLE TOTAL ROOFING SYSTEM OR ITS COMPONENTS. THERE ARE NO WARRANTIES EITHER EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, WHICH EXTEND BEYOND THE FACE HEREOF. CARLISLE SHALL NOT BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR OTHER DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR DAMAGE TO THE BUILDING OR ITS CONTENTS UNDER ANY THEORY OF LAW.

BY: Patrick D. McGrady

AUTHORIZED SIGNATURE.....

Patrick D. McGrady

TITLE: V.P., Technical & Warranty Services

THIS WARRANTY EXPIRES: AUGUST 15, 2025

ROOFING AMERICA FOR OVER 40 YEARS..

CARLISLE

P. O. Box 7000, Carlisle, PA 17013 ■ (717) 245-7000; Fax (717) 245-7053 ■ www.carlisle-syntec.com



Single-Ply System

4-113

SERIAL NO. TS52551

DATE OF ISSUE: SEPTEMBER 21, 2004

CARLISLE GOLDEN SEAL™ TOTAL ROOFING SYSTEM WARRANTY

BUILDING OWNER: TEMPLE UNIVERSITY HEALTH SYSTEMS
NAME OF BUILDING: TEMPLE HOSPITAL-ANCILLARY BUILDING

CHDO40519L

BUILDING ADDRESS: PHILADELPHIA, PA

JSI/REV.1

DATE OF COMPLETION OF THE CARLISLE TOTAL ROOFING SYSTEM: 09/10/04

DATE OF ACCEPTANCE BY CARLISLE: SEPTEMBER 21, 2004

Carlisle Roofing Systems, Inc., warrants to the Building Owner (OWNER) of the above described building, that; subject to the terms, conditions and limitations stated in this warranty, Carlisle will repair any leak in the Carlisle Golden Seal™ Total Roofing System (CARLISLE TOTAL ROOFING SYSTEM) installed by a Carlisle Authorized Roofing applicator for a period of 20 years commencing with the date of Carlisle's acceptance of the Carlisle Total Roofing System installation. However, in no event shall Carlisle's obligations extend beyond 20.5 years subsequent to the date of substantial completion of the Carlisle Total Roofing System. See below for exact date of warranty expiration.

The Carlisle Total Roofing System is defined as the following Carlisle brand materials: Membrane, Flashings, Counterflashings, Adhesives and Sealants, Insulation, Recovery Board, Fasteners, Fastener Plates, Fastening Bars, Metal Edging, Metal Termination Bars, and any other Carlisle brand products utilized in this installation.

TERMS, CONDITIONS, LIMITATIONS

- Owner shall provide Carlisle with written notice within thirty (30) days of the discovery of any leak in the Carlisle Total Roofing System. Owner should send written notice of a leak to Carlisle's Warranty Services Department at the address set forth at the bottom of this warranty. By so notifying Carlisle, the Owner authorizes Carlisle or its designee to investigate the cause of the leak. Should the investigation reveal the cause of the leak to be outside the scope of this Warranty, investigation and repair costs for this service shall be paid by the Owner.
- If, upon inspection, Carlisle determines that the leak is caused by a defect in the Carlisle Total Roofing System's materials, or workmanship of the Carlisle Authorized Roofing Applicator in installing the same, Owner's remedies and Carlisle's liability shall be limited to Carlisle's repair of the leak.
- This warranty shall not be applicable if, upon Carlisle's inspection, Carlisle determines that any of the following has occurred:
 - The Carlisle Total Roofing System is damaged by natural disasters, including, but not limited to, lightning, fire, insect infestations, earthquakes, tornado, hail, hurricanes, and winds of peak gust speeds of 80 mph or higher measured at 10 meters above ground; or
 - The Carlisle Total Roofing System is damaged by any intentional or negligent acts, accidents, misuse, abuse, vandalism, civil disobedience, or the like.
 - Deterioration or failure of building components, including, but not limited to, the roof substrate, walls, mortar, HVAC units, non-Carlisle brand metal work, etc., occurs and causes a leak, or otherwise damages the Carlisle Total Roofing System; or
 - Acids, oils, harmful chemicals and the like come in contact with the Carlisle Total Roofing System and cause a leak, or otherwise damage the Carlisle Total Roofing System.
- This Warranty shall be null and void if any of the following shall occur:
 - If, after installation of the Carlisle Total Roofing System by a Carlisle Authorized Roofing Applicator there are any alterations or repairs made on or through the roof or objects such as, but not limited to, structures, fixtures, or utilities are placed upon or attached to the roof without first obtaining written authorization from Carlisle; or
 - Failure by the Owner to use reasonable care in maintaining the roof, said maintenance to include, but not be limited to, those items listed on Carlisle's Care & Maintenance Information sheet which accompanies this Warranty.
- Only Carlisle brand insulation products are covered by this warranty. Carlisle specifically disclaims liability, under any theory of law, for damages sustained by or caused by non-Carlisle brand insulation products.
- During the term of this Warranty, Carlisle shall have free access to the roof during regular business hours.
- Carlisle shall have no obligation under this Warranty while any bills for installation, supplies, service, and warranty charges have not been paid in full to the Carlisle Authorized Roofing Applicator, Carlisle, or material suppliers.
- Carlisle's failure at any time to enforce any of the terms or conditions stated herein shall not be construed to be a waiver of such provision.
- Carlisle shall not be responsible for the cleanliness or discoloration of the Carlisle Total Roofing System caused by environmental conditions including, but not limited to, dirt, pollutants, or biological agents.
- Carlisle shall have no liability under any theory of law for any claims, repairs, restoration, or other damages including, but not limited to, consequential or incidental damages relating, directly or indirectly, to the presence of any irritants, contaminants, vapors, fumes, molds, fungi, bacteria, spores, mycotoxins, or the like in the building or in the air, land, or water serving the building.
- This warranty is not assignable by operation of law or otherwise. Application may be made by a new building owner for reissuance of the warranty during the original warranty period. Certain procedures including, but not limited to, an inspection of the Roofing System by a Carlisle representative and fees will apply to any reissuance. Carlisle reserves the right, in its sole discretion, to refuse to reissue this warranty.

CARLISLE DOES NOT WARRANT PRODUCTS UTILIZED IN THIS INSTALLATION WHICH IT HAS NOT FURNISHED; AND SPECIFICALLY DISCLAIMS LIABILITY, UNDER ANY THEORY OF LAW, ARISING OUT OF THE INSTALLATION AND PERFORMANCE OF, OR DAMAGES SUSTAINED BY OR CAUSED BY, PRODUCTS NOT FURNISHED BY CARLISLE.

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BY: Patrick D. McGrady

AUTHORIZED SIGNATURE.....

TITLE: V.P., Technical & Warranty Services

THIS WARRANTY EXPIRES: SEPTEMBER 20, 2024

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CARLISLE

GOLDEN SEAL Total Roofing System WARRANTY

SERIAL NO. 10060243

004

DATE OF ISSUE: October 28, 2010

BUILDING OWNER: TASB

NAME OF BUILDING: TEMPLE UNIVERSITY ANCILLARY BLDG, OPERATING ROOM AND MRI

BUILDING ADDRESS: 3401 NORTH BROAD STREET, PHILADELPHIA, PA

DATE OF COMPLETION OF THE CARLISLE TOTAL ROOFING SYSTEM: 10/27/2010

DATE OF ACCEPTANCE BY CARLISLE: 10/28/2010

(EB Warranty)

CMD1078069

Carlisle Roofing Systems, Inc., warrants to the Building Owner (Owner) of the above described building, that; subject to the terms, conditions, and limitations stated in this warranty, Carlisle will repair any leak in the Carlisle Golden Seal™ Total Roofing System (Carlisle Total Roofing System) installed by a Carlisle Authorized Roofing applicator for a period of 20 years commencing with the date of Carlisle's acceptance of the Carlisle Total Roofing System installation. However, in no event shall Carlisle's obligations extend beyond 20.5 years subsequent to the date of substantial completion of the Carlisle Total Roofing System. See below for exact date of warranty expiration.

The Carlisle Total Roofing System is defined as the following Carlisle brand materials: Membrane, Flashings, Counterflashings, Adhesives and Sealants, Insulation, Recovery Board, Fasteners, Fastener Plates, Fastening Bars, Metal Edging, Metal Termination Bars, and any other Carlisle brand products utilized in this installation.

TERMS, CONDITIONS, LIMITATIONS

- 1 Owner shall provide Carlisle with written notice within thirty (30) days of the discovery of any leak in the Carlisle Total Roofing System. Owner should send written notice of a leak to Carlisle's Warranty Services Department at the address set forth at the bottom of this warranty. By so notifying Carlisle, the Owner authorizes Carlisle or its designee to investigate the cause of the leak. Should the investigation reveal the cause of the leak to be outside the scope of this Warranty, investigation and repair costs for this service shall be paid by the Owner.
- 2 If, upon inspection, Carlisle determines that the leak is caused by a defect in the Carlisle Total Roofing System's materials or workmanship of the Carlisle Authorized Roofing Applicator in installing the same, Owner's remedies and Carlisle's liability shall be limited to Carlisle's repair of the leak.
- 3 This warranty shall not be applicable if, upon Carlisle's inspection, Carlisle determines that any of the following has occurred:
 - (a) The Carlisle Total Roofing System is damaged by natural disasters, including, but not limited to lightning, fire, insect infestations, earthquake, tornado, hail, hurricanes, and winds of peak gust speeds of 55 mph or higher measured at 10 meters above ground, or
 - (b) The Carlisle Total Roofing System is damaged by any intentional or negligent acts, accidents, misuse, abuse, vandalism, civil disobedience or the like
 - (c) Deterioration or failure of building components, including, but not limited to, the roof substrate, walls, mortar, HVAC units, non-Carlisle brand metal work, etc., occurs and causes a leak, or otherwise damages the Carlisle Total Roofing System; or
 - (d) Acids, oils, harmful chemicals and the like come in contact with the Carlisle Total Roofing System and cause a leak or otherwise damage the Carlisle Total Roofing System.
- 4 This Warranty shall be null and void if any of the following shall occur:
 - (a) If, after installation of the Carlisle Total Roofing System by a Carlisle Authorized Roofing Applicator there are any alterations or repairs made on or through the roof or objects such as, but not limited to, structures, fixtures, or utilities are placed upon or attached to the roof without first obtaining written authorization from Carlisle, or
 - (b) Failure by the Owner to use reasonable care in maintaining the roof, said maintenance to include, but not be limited to, those items listed on Carlisle's Care & Maintenance Information sheet which accompanies this Warranty.
- 5 Only Carlisle brand insulation products are covered by this warranty. Carlisle specifically disclaims liability, under any theory of law, for damages sustained by or caused by non-Carlisle brand insulation products.
- 6 During the term of this Warranty, Carlisle shall have free access to the roof during regular business hours.
- 7 Carlisle shall have no obligation under this Warranty while any bills for installation, supplies, service, and warranty charges have not been paid in full to the Carlisle Authorized Roofing Applicator, Carlisle, or material suppliers.
- 8 Carlisle's failure at any time to enforce any of the terms or conditions stated herein shall not be construed to be a waiver of such provision.
- 9 Carlisle shall not be responsible for the cleanliness or discoloration of the Carlisle Total Roofing System caused by environmental conditions including, but not limited to, dirt, pollutants, or biological agents.
- 10 Carlisle shall have no liability under any theory of law for any claims, repairs, restoration, or other damages including, but not limited to consequential or incidental damages relating, directly or indirectly, to the presence of any irritants, contaminants, vapors, fumes, molds, fungi, bacteria, spores, mycotoxins, or the like in the building or in the air, land, or water serving the building.
- 11 This warranty is not assignable by operation of law or otherwise. Application may be made by a new building owner for reissuance of the warranty during the original warranty period. Certain procedures including, but not limited to, an inspection of the Roofing System by a Carlisle representative and fees will apply to any reissuance. Carlisle reserves the right, in its sole discretion, to refuse to re-issue this warranty.

CARLISLE DOES NOT WARRANT PRODUCTS UTILIZED IN THIS INSTALLATION WHICH IT HAS NOT FURNISHED; AND SPECIFICALLY DISCLAIMS LIABILITY, UNDER ANY THEORY OF LAW, ARISING OUT OF THE INSTALLATION AND PERFORMANCE OF, OR DAMAGES SUSTAINED BY OR CAUSED BY, PRODUCTS NOT FURNISHED BY CARLISLE.

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BY Robert H McNeill

AUTHORIZED SIGNATURE

TITLE Director, Technical and Warranty Services

This Warranty Expires: October 27, 2030

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CARLISLE

Carlisle SynTec

WA-F0001 (12/07)

Belcher Roofing Corporation
111 Commerce Drive
Montgomeryville, PA 18936
Telephone 215-362-5400 Fax 215-362-9338 E-Mail info@belcherroofing.com

Roof Warranty

Owner/ Warranty Holder Temple Univ. Admin. Services c/o Frank Connelly
Address of Owner and Warranty Holder 3525 Germantown Avenue, Philadelphia, Pa. 19140
Location of Building where roof is warranted: Ancillary Bldg. - 3401 N. Broad St., Phila., Pa.
Roofing Specifications: Carlisle Area covered: 15800 square feet
Warranty Start Date 10/28/2010 Date this Warranty Expires: 10/27/2012

BELCHER ROOFING CORPORATION (BRC) hereby warrants, subject to the terms and conditions set forth herein, that it will at no cost to Owner make repairs to leaks which result from defects in workmanship and materials furnished and installed by BELCHER ROOFING CORPORATION if such leaks are reported and occur within the 2 year term of this warranty. Upon receipt of notice of purported or suspected leaks from Owner, BRC shall inspect and make emergency temporary repairs as required to stop leaks and, if required, make permanent additional repairs to the leak area within a reasonable time thereafter as conditions permit. This warranty applies to the same exact items, description, areas and physical extents as the manufacturers warranty only and is made under and subject to the following terms and conditions:

(1) In order to obtain performance of any warranty obligation, the Owner must first notify BRC of any repairs that may be subject to this warranty. Notice may be given verbally, but in order to pursue any claim that BRC has not honored for this warranty, notification of a leak must be given to BRC in writing at the address shown below within 48 hours after a leak is experienced. BRC shall make repairs as soon as reasonably possible upon such notification of reported defects in BRC materials and/or workmanship. It is the responsibility of the Owner to inspect ceilings and overhangs periodically for signs of leakage and to report any such leakage.

(2) BRC will not be responsible for any leaks caused by (1) Acts of God such as, but in no way limited to, lightning, tornados, hurricanes and hail; (2) Structural elements of the building, including, but not limited to, cracking, structural movement, settlement, deflection, deterioration and decomposition of walls, foundation or the roof deck or substrate; (3) Parapet walls, copings, chimneys, skylights, vents, equipment supports and any other edge or other conditions and penetrations of the roofing work, unless such work was performed by BRC; (4) Deficiently designed roofs that may have inadequate drainage, slope or other conditions beyond the control of BRC which cause ponding or standing of water on the roof; (5) Discharge of harmful materials onto the roof or contamination by damaging substances; (6) Services to or maintenance of rooftop equipment or traffic on the roof; (7) Abuse, misuse, accident or negligence by any person other than BRC; and (8) Failure of Owner to perform normal maintenance, (9) Acts of terrorism.

(3) If after inspection, BRC determines that repair work is due to one of the causes mentioned in Paragraph 2 above or some other reason other than a defect in workmanship or materials furnished and installed by BRC, BRC shall notify the Owner and give to the Owner an estimated cost to perform the work required.

(4) No work shall be done on BRC warranted roof, including, but not limited to, openings made for flues, vents, drains, sign braces or any other equipment fastened to or set on the roof or in any way impacts the roof in any way, unless BRC shall be first notified and shall make, at the expense of the Owner, the necessary roofing additions, changes or corrections thereto as may be required. Failure to observe this condition shall render this warranty null and void.

(5) BRC shall not be liable or responsible for any loss or damage resulting from failure to perform the services as herein provided when such failure is caused by fire, flood, strike or any other cause which is unavoidable or beyond the control of BRC.

(6) Nothing in this warranty shall render BRC liable in any respect for any damage to the Owner's building or any contents thereof, or interruption of any business conducted in the building or any other liquidated, contingent, consequential, special or other damages, financial or otherwise. IN NO WAY WHATSOEVER WILL BRC BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

(7) This warranty is intended solely for the benefit of the Owner named above and is not transferable or assignable by the Owner without the express written consent of BRC.

(8) BRC shall not be obligated to make repairs under this warranty unless all bills for installation, supplies, repairs, or service in connection with the roofing system covered by this warranty have been paid in full.

(9) BRC's obligation to make repairs to leaks during the term of this warranty is its sole and exclusive obligation to Owner. BRC shall have no obligation with respect to the roof upon expiration of the warranty period set forth above.

(10) BRC SHALL HAVE NO OBLIGATIONS WHATSOEVER TO ANY PARTY WHATSOEVER FOR ANY SERVICES, WARRANTY OR OTHERWISE, WHILE THERE REMAINS ANY OUTSTANDING UNPAID AMOUNTS DUE TO BRC FOR MATERIALS, LABOR, SERVICES OR WORK PERFORMED IN CONJUNCTION WITH THE ISSUANCE OF THIS BRC WARRANTY.

THIS WARRANTY IS GIVEN AND ACCEPTED IN LIEU OF ALL OTHER LIABILITY OR WARRANTIES ON THE PART OF BRC, EXPRESSED OR IMPLIED, IN FACT OR IN LAW, ALL WARRANTIES AND SPECIFICALLY THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY EXCLUDED AND DISCLAIMED.

MEMBER:
ROOFING CONTRACTORS
ASSOCIATION OF PHILADELPHIA

NATIONAL ROOFING
CONTRACTORS ASSOCIATION

BELCHER ROOFING CORPORATION
111 COMMERCE DRIVE
MONTGOMERYVILLE, PA 18936

By: 

NAME AND TITLE : THOMAS BELCHER TREASURER



Hamada, INC. ROOFING

2848 FRANKFORD AVENUE
PHILADELPHIA, PA 19134
Philadelphia Area (215) 427-2100

COMMERCIAL ROOF WARRANTY

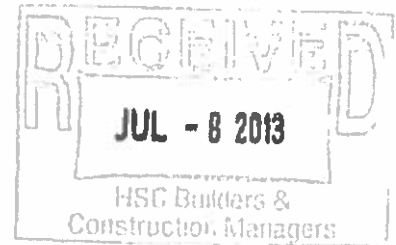
TO: Temple University Hospital Robotics Suite OR Renovation

Name (Owner)

3401 N. Broad St.

Address

Philadelphia PA 19140



Date of Completion: March 18, 2013 Date of Expiration: March 17, 2014

Hamada, Inc. (hereinafter "Hamada") hereby warrants, subject to the terms and conditions set forth herein, that for a period of 1 year from the date of completion, Hamada will, free of charge to the Owner, make repairs to leaks in the roof membrane and membrane flashing installed by Hamada resulting from defects in workmanship applied by or through Hamada. Hamada shall, within the warranty period and during normal working hours, inspect and furnish the labor and materials to repair leaks covered under this Warranty at no cost to Owner.

This Warranty is made under and subject to the following terms and conditions:

1. In order for this Warranty to be effective, the Owner must first notify Hamada of any repairs required under this Warranty. Notice may be given orally, but in order to pursue any claim that Hamada has not honored this Warranty, notification of a leak must be given to Hamada in writing at the address shown above within five (5) days after a leak is experienced. Hamada shall make repairs as soon as practicable after notification.

2. This Warranty does not extend to conditions caused by, and Hamada shall not be responsible for, leaks caused by (1) abuse, misuse, lack of maintenance, accident or negligence in maintaining the roof by any person other than Hamada, (2) lightning, hail, windstorm, hurricane, earthquake, acid rain, thermal shock or ice storm or other acts of God; (3) other building components, including cracking, building movement, settlement, deflection of roof deck, deterioration of walls, water entry through masonry or other points other than the roof, and defects in the materials used as a base under the roof; (4) faulty vents, equipment supports, and other penetrations of the roof work and edge conditions, unless such work was performed by Hamada; (5) service to or maintenance of any roof top equipment or traffic of any nature on the roof; (6) acts or omissions of other trades or contractors; (7) movement of metal work; (8) ponding of water; (9) discharge of vegetable, mineral, animal oils, greases solvents or chemicals, such as industrial wastes upon the roof surface; or (10) damage caused by birds or animals.

3. No work shall be done on said roof, including, but without limitation, openings made for flues, vents, drains, sign braces, railings, or other equipment fastened to or set on the roof, and no repairs or alterations shall be made to the roof, unless Hamada shall first be notified and be given the opportunity, at the expense of the Owner, to make the necessary application thereto. Failure to observe this condition shall render this Warranty null and void with respect to any area of the roof affected thereby.

4. Nothing in this Warranty shall render Hamada liable in any respect for any damage to the Owner's building, or any components or contents thereof, mold, mildew or interruption of any business conducted in the building. Owner should inspect ceilings and overhangs periodically for signs of leakage.

HAMADA, INC. SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

5. This Warranty is intended solely for the benefit of the Owner named above and is not transferable or assignable by the Owner without the express written consent of Hamada.

6. This Warranty shall not be effective unless Hamada has received full payment for installation, repairs, or service in connection with the roofing system covered by this Warranty. If Hamada is called upon to investigate a reported leak and the condition is determined not to be covered under this warranty, Owner will compensate Hamada for repairs, if any, and time expended by Hamada.

7. Hamada's obligation to make repairs to leaks resulting from a deficiency in its workmanship during the term of this Warranty is its sole and exclusive obligation to Owner and Owner's exclusive remedy against Hamada. This warranty is not a maintenance contract. Upon expiration of the warranty, Hamada shall have no further obligation.

THIS WARRANTY IS GIVEN AND ACCEPTED IN LIEU OF ALL OTHER LIABILITY OR WARRANTIES ON THE PART OF HAMADA, INC. EXPRESS OR IMPLIED, IN FACT OR IN LAW. ALL IMPLIED WARRANTIES AND SPECIFICALLY THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED AND DISCLAIMED.

8. Any claim alleging any breach of this Warranty or any other claim against Hamada shall be resolved through arbitration and must be initiated no later than one (1) year after expiration of this Warranty.

9. The cost for removal and subsequent replacement of any material(s), which covers or otherwise conceals the Roofing material, is excluded from this Warranty and is the responsibility of the Owner.

10. This Warranty is strictly limited to the roof area where re-roofing was performed by Hamada under its Project Amendment Agreement dated October 18, 2012 with HSC Builders & Construction Managers. Further, this warranty is not intended to cover the entire existing roof. Should leaks develop in areas of the existing roof where work was not performed by Hamada under the Project Amendment Agreement referenced herein and migration occurs to areas of the roof where work was performed by Hamada this warranty shall be invalid.

HAMADA, INC.

By:
Zachary Hamada
President

SECTION 072100.C - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Requirements:
 - 1. Section 07 5423 "Thermoplastic Polyolefin (TPO) Roofing" for polyisocyanurate roof insulation.

1.2 DEFINITIONS

- A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

1.3 PERFORMANCE REQUIREMENTS

- A. Plenum Rating: Provide glass-fiber insulation where indicated in ceiling plenums whose test performance is rated as follows for use in plenums as determined by testing identical products per "Erosion Test" and "Mold Growth and Humidity Test" described in UL 181, or on comparable tests from another standard acceptable to authorities having jurisdiction.
 - 1. Erosion Test Results: Insulation shows no visible evidence of cracking, flaking, peeling, or delamination of interior surface of duct assembly, after testing for 4 hours at 2500-fpm air velocity.
 - 2. Mold Growth and Humidity Test Results: Insulation shows no evidence of mold growth, delamination, or other deterioration due to the effects of high humidity, after inoculation with Chaetomium globosium on all surfaces and storing for 60 days at 100 percent relative humidity in the dark.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

- B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Surface-Burning Characteristics: ASTM E 84.
2. Fire-Resistance Ratings: ASTM E 119.
3. Combustion Characteristics: ASTM E 136.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 APPLICATIONS

- A. Insulation in metal framed walls: Batt insulation with no vapor retarder

2.2 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
1. Glass-Fiber Insulation: ASTM C 764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E 84.
 2. Spray Polyurethane Foam Insulation: ASTM C 1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.
- C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
- E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.4 INSTALLATION OF INSULATION

- A. On units of rigid board insulation, install pads of adhesive spaced approximately 24 inches o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates indicated.

3.5 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 076200.C - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Shop- and field-formed sheet metal accessories and trim.
- B. Related Sections:
 - 1. Section 06 10 53 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Division 07 roofing Sections for installing sheet metal flashing and trim integral with roofing.
 - 3. Section 07 72 00 "Roof Accessories" for roof hatches, preformed flashing sleeves, and other manufactured roof accessory units.
 - 4. Section 07 95 00 "Expansion Control" for manufactured sheet metal expansion-joint covers.
 - 5. Mechanical Sections for mechanical sheet metal work and flashings and collars for mechanical work.
 - 6. Electrical Sections for flashings and collars for electrical work.

1.3 SYSTEM DESCRIPTION

- A. Delegated Design Requirements: Fabricate and install work of this Section to meet or exceed the performance criteria specified; to conform to the profiles indicated and to other requirements of the Contract Documents; to satisfy the requirements of the authorities having jurisdiction; and to provide structurally sound, weathertight assemblies capable of withstanding exposure to weather, wind loads, and structurally- and thermally-induced movement without failing, rattling, leaking, or fastener disengagement.
- B. Performance Requirements:
 - 1. Thermal Movements:
 - a. Provide sheet metal flashings and trim that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures without buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.
 - 1) Minimum 120 deg. F, ambient temperature change.
 - 2) Minimum 180 deg. F, material surfaces temperature change.
 - b. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

- c. Fasteners: Provide fasteners that resist rotation and avoid shear stress as a result of thermal movements.
2. Water Infiltration: Provide sheet flashings and sheet metalwork that prohibit water infiltration to building interior.

1.4 ACTION SUBMITTALS

- A. Product Data: For prefabricated assemblies, submit a list of proposed products, materials, and components to be provided for a complete assembly, along with manufacturer's product data, specifications, typical installation details, and other data as necessary to demonstrate compliance with the specified requirements for each item listed.
- B. Shop Drawings: Submit minimum 1/2 inch scale, dimensioned drawings showing materials, profiles, joints, finishes, methods of fabrication, and anchorage details.
 1. Label individual components and indicate material gage and method of field installation.
 2. Show connections to adjacent construction.
 3. Furnish isometric drawings for conditions too difficult to illustrate in 2 dimensions.
 4. Where sheet metal is applied to surfaces other than wood, furnish detailed shop drawings showing locations of required furring and nailing strips specified in Division 06 Sections.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.7 WARRANTY

- A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.

- c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: Twenty (20) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
 1. Exposed Coil-Coated Finishes:
 - a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Color: As indicated by on Drawings or as selected by Owner from manufacturer's standard range.
 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304, dead soft, fully annealed.
 1. Finish: 4 (polished directional satin) unless noted otherwise on the Drawings.
- D. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, commercial steel (CS) Type B or structural steel (SS) grade 25, minimum G90 coating designation.
 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.

- b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 - 3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
 - 4. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.
- C. Solder:
- 1. For Stainless Steel: ASTM B 32, Grade Sn60, with an acid flux of type recommended by stainless-steel sheet manufacturer.
 - 2. For Zinc-Coated (Galvanized) Steel: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
- E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
- 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 - 2. Obtain field measurements for accurate fit before shop fabrication.
 - 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 - 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
- C. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant.
- D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

- E. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
- F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.
- G. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.
- H. Do not use graphite pencils to mark metal surfaces.

2.4 FABRICATED ROOF DRAINAGE COMPONENTS

- A. Material: Minimum 24 gage (0.0250-inch USS) thick stainless steel sheet.
- B. Design: Provide standard profiles from SMACNA Architectural Sheet Metal Manual, Chapter 1.
 - 1. Conductor Heads: Figure 1-25F.
 - 2. Scuppers: Figure 1-30.
 - 3. Downspouts: Figure 1-32A.
 - 4. Downspout Hanger: Figure 1-35D.

2.5 FABRICATED COPINGS

- A. Material: Provide minimum 0.0625 inch aluminum sheet.
- B. Design:
 - 1. Profile: SMACNA Architectural Sheet Metal Manual, Chapter 3, Figure 3-4B.
 - 2. Coping Side Dimension: As indicated.
 - 3. Coping Top Width: As indicated.
 - 4. Corner Style: "Coping Forming Guide Limits," Page 3.5, corner style C1.
 - 5. Face Edge Style: "Coping Forming Guide Limits," Page 3.5, fascia edge style E2.
 - 6. Joint Style: Table 3-1, J10, 3/4 inch hook seam.

2.6 FABRICATED FLASHING

- A. Through-Wall Flashing: Minimum 20-gage (0.0375 inch USS) thick stainless steel sheet.
- B. Counterflashing: Minimum 20-gage (0.0375 inch USS) thick stainless steel sheet.

2.7 MISCELLANEOUS SHEET METAL FABRICATIONS

- A. Not Used

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.
 - 1. Verify compliance with requirements for installation tolerances of substrates.
 - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL REQUIREMENTS

- A. Comply with manufacturer's installation instructions and applicable SMACNA and NRCA details, except as indicated on the Drawings and specified.
- B. Coordinate this work with other trades whose work penetrate, intersect, and adjoin flashings and sheet metal work, to permit the correct sequencing and the watertightness of the assemblies.
- C. Install counterflashing assemblies at a constant height above the roof.
 - 1. Anchor counterflashing securely into reglet by friction, or provide lead wedges spaced 2-foot O.C. maximum.
 - 2. Use manufacturer's standard splice plates and preformed corners for a weathertight assembly.

3.3 INSTALLATION

- A. General:
 - 1. Install sheet metal work in accordance with the approved Shop Drawings.
 - 2. Install plumb, level, and tight, with flush joints, and with lines, arises, and angles sharp and true. Securely attach to adjacent construction.
 - 3. Fold exposed edges neatly to form a 1/2 inch hem on the concealed side; hem all exposed edges, unless otherwise indicated.
 - 4. Lap flashing joints 4 inches minimum.
 - 5. Assemble work so face of metal in contact has hairline joints, except where required for expansion or fitting.
 - 6. Conceal fastenings and reinforcement where they would be visible by the public and the building occupants.
 - 7. Finish work shall be straight, smooth and continuous, without dimples, dents, and other damage.
 - 8. Continuously weld or solder coping corners.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.

1. Coat back side of uncoated aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Soldering: Solder all joints not intended for expansion and contraction.
1. Clean material and tin prior to soldering. Solder with heavy coppers properly tinned before use.
 2. Solder slowly. Heat the seams thoroughly, and completely fill with solder.
 3. Make exposed soldering on finish surfaces neatly, full flowing and smooth.
 4. Wash acid flux with a soda solution after soldering and remove soldering flux on exposed surfaces.
- D. Nailing:
1. Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inches. Nailing of flashings shall be confined to one edge only.
 2. Space nails evenly maximum 12 inches O.C., and approximately 2 inches from edge.
 3. Face nailing is not permitted. Do not nail sheet metal assemblies on horizontal surfaces.
- E. Cleats:
1. Provide cleats for sheet metal 18 inches in width and over. Space cleats evenly not over 12 inches O.C.
 2. Make cleats not less than 2 inch wide by 3 inch long, and of the same material and thickness as the sheet metal being installed.
 3. Secure one end of cleat using 2 nails with the cleat folded back over the nail heads. Lock the other end into the seam. Pre-tin cleats for soldered seams.
- F. Bolts, Rivets, and Screws:
1. Pre-drill penetrations and touch up cut edges with galvanizing repair paint.
 2. Install bolts, rivets, and screws where indicated or required.
 3. Provide compatible washers to protect surface of sheet metal and to provide a watertight connection.
- G. Dissimilar Metal Protection:
1. Protect sheet metal in contact with dissimilar metals, concrete, masonry, and plaster with a heavy coating of bituminous paint or approved separation tape.
 2. Set sheet metal assemblies supported by pressure-treated wood nailer, except set copings on flexible flashing specified. Lap on vertical surfaces at least 2 inches.
- H. Seams: Make seams straight and uniform in width and height with no solder showing on the face. Finish soldered seams not less than one inch wide. Overlap seams not soldered at least 3 inches.
- I. Expansion and Contraction:
1. Provide thermal expansion joints within 18 inches, measured on the interior side, from each direction of corners.
 2. Provide for thermal and building movement without over-stressing the material, breaking connections or producing wrinkles and distortion in finished surfaces. Make sheet metal installations weathertight at all locations.

3. Provide expansion and contraction joints at not more than 40 feet intervals, except where the distance between the last expansion joint and the end of the continuous run is more than half the required interval spacing, provide an additional joint. Exposed surfaces shall be free from visible wave, warp, and buckle.
- J. Completed Work: Completed flashings and sheet metal work shall be watertight, free of tool marks, dents, scratches, and other damages, with joints and corners accurately machined, filed, and fitted, and rigidly framed together and connected.

3.4 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch (offset of adjoining faces and of alignment of matching profiles.

3.5 CLEANING AND PROTECTION

- A. Clean and neutralize flux materials. Clean off excess solder.
- B. Clean off excess sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 62 00

SECTION 078100.C - APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 DEFINITIONS

- A. SFRM: Sprayed fire-resistive material.

1.2 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. ASTM E736/E736M - Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members.
- C. ASTM E759/E759M - Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members.
- D. ASTM E760/E760M - Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members.
- E. ASTM E859/E859M - Standard Test Method for Air Erosion of Sprayed Fire-Resistive Materials (SFRMs) Applied to Structural Members.
- F. ASTM E937/E937M - Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members.
- G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

1.3 SUBMITTALS

- A. Product Data:
1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 2. Evidence that the spray-applied fireproofing has been subjected to full-scale ASTM E119 fire testing by the manufacturer at UL or other testing agency approved by code authorities having jurisdiction.
 3. Schedule indicating material to be used, building elements to be protected with spray-applied fireproofing, hourly rating and material thickness provided and appropriate references.
 4. Independent laboratory test results for fireproofing shall be submitted for all specified performance criteria.
 5. Manufacturer's installation instructions.

- B. Certification: Manufacturer's affidavit that materials used in Project contain no asbestos.

1.4 QUALITY ASSURANCE

- A. Installer: Company specializing in applying the Work of this Section with minimum three (3) years experience and approved by manufacturer.
- B. Products, execution, and fireproofing thicknesses shall conform to the required fire-resistance ratings requirements of code authorities having jurisdiction.
- C. Provide certificate of compliance for fireproofing materials to requirements of code authority having jurisdiction indicating approval for use on this Project.

1.5 PRE-INSTALLATION CONFERENCE

- A. Contractor, fireproofing subcontractor, fireproofing manufacturer, independent testing laboratory, and Architect shall attend a pre-installation conference to review the substrates for acceptability, method of application, applied thicknesses, inspection procedures and other issues.

1.6 TESTS AND INSPECTIONS

- A. Architect may require tests and inspections as necessary to verify quality, strength, and thickness of sprayed fireproofing. Laboratory tests of materials for resistance to damage, bond strength, and air erosion will be made in accordance with referenced ASTM standard procedures.
- B. Owner will engage Testing Laboratory and Owner will pay for initial tests of Testing Laboratory. Work which fails initial testing shall be replaced with new materials. Retesting shall be at Contractor's expense until test results are satisfactory to Architect.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver material in manufacturer's original unopened packages, fully identified as to manufacturer, brand or other identifying data and bearing the proper UL labels for Surface Burning Characteristics and Fire Resistance Classification.
- B. Storage and Handling:
 - 1. Store material off the ground, under cover, and in a dry location until ready for use.
 - 2. Bags which have been exposed to water before use shall be found unsuitable and discarded.
 - 3. Stock of material shall be rotated and used prior to its expiration date.

1.8 PROJECT/SITE CONDITIONS

- A. When the prevailing outdoor temperature at the building is less than 40 degrees F, a minimum substrate and ambient temperature of 40 degrees F shall be maintained prior to, during and for a minimum of 24 hours after application of the spray-applied fireproofing. If necessary for job progress, Contractor shall provide enclosures with heat to maintain temperatures.
- B. Provide ventilation to allow proper drying of spray-applied fireproofing during and subsequent to its application.

1.9 SEQUENCING AND SCHEDULING

- A. Sequence and coordinate application of spray-applied fireproofing with work in other sections which would interfere with efficient fireproofing application.

1.10 WARRANTY

- A. Warrant the work specified herein for five (5) years against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship. Repair or reinstall failures or damaged fireproofing to achieve required fire resistive ratings at no additional expense to Owner.
- B. Defects shall include, but not be limited to, the following:
 - 1. Non-compliance with specifications.
 - 2. Loss of fire resistance rating
 - 3. Cracking, checking, dusting or flaking.
 - 4. Spalling or separation from structural substrate.
 - 5. Blooming, blistering or peeling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Applied fire protection:
 - 1. GCP Applied Technologies

2.2 MATERIALS

- A. Fire Resistance Classification: The spray-applied fireproofing material shall have been tested and reported by Underwriters Laboratories Inc. in accordance with the procedures of ASTM E119 and shall be listed in the UL Fire Resistance Directory.
- B. Spray-applied fire resistive materials shall be free of all forms of asbestos, including actinolite, amosite, anthophyllite, chrysotile, crocidolite and tremolite. Material manufacturer shall provide certification of such.

- C. Water: Mixing water shall be clean, fresh, and suitable for domestic consumption and free from such amounts of mineral or organic substances as would affect the set of the fireproofing material. Provide water with sufficient pressure and volume to meet the fireproofing application schedule.

2.3 ACCESSORIES

- A. Provide accessories to comply with manufacturer's recommendations and to meet fire resistance design and code requirements. Such accessories include, but are not limited to, any required items such as bonding agents, mechanical attachments; application aids such as metal lath, scrim, or netting; and manufacturer's recommended accelerator.

2.4 SOURCE QUALITY CONTROL

- A. Submit evidence that the fireproofing has been tested in accordance with ASTM E119 by UL or other testing agency approved by code authorities having jurisdiction. Include evidence that the fire testing was sponsored by the manufacturer and that the material tested was produced at the manufacturer's facility under the supervision of personnel by said testing agency. Letters documenting classification status are not acceptable evidence of compliance with this Section.

2.5 EXTRA PATCHING MATERIAL

- A. Installer/subcontractor to provide General Contractor with additional materials for patching of previously applied material damaged by other trades after fireproofing installer has completed work and has left site. Provide material equal to one percent of total project quantity.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Surfaces to receive spray-applied fireproofing shall be provided free of oil, grease, paints/primers, loose mill scale, dirt or other foreign substances which may impair proper adhesion of the fireproofing to the substrate. Where necessary, cleaning or other corrections of surfaces to receive fireproofing shall be the responsibility of the supplier of the incompatible substrate.
- B. Application of the fireproofing shall not begin until the contractor, applicator and fireproofing testing laboratory (inspector) have examined surfaces to receive fireproofing and determined that the surfaces are acceptable to receive the fireproofing material.

3.2 PREPARATION

- A. All surfaces to receive fire protection shall be free of oil, grease, loose mill scale, dirt, paints/primers (other than those listed and tested) or other foreign materials which would impair satisfactory bonding to the surface. Any cleaning of surfaces to receive sprayed fire protection shall be the responsibility of the General Contractor or Steel Erector, as outlined in the structural steel or steel deck section.
- B. Clips, hangers, supports, sleeves and other attachments to the substrate shall be placed prior to the application of spray-applied fire resistive materials.
- C. The installation of ducts, piping, conduit or other suspended equipment shall not take place until the application of sprayed fire protection is complete in an area.
- D. The spray-applied fire resistive material shall only be applied to steel deck which has been constructed in accordance with the criteria set forth by the Steel Deck Institute.
- E. On roof decks without a concrete cover, complete all roofing applications and roof mounted equipment installation prior to application of the fireproofing to the underside of roof decking and supporting beams and joists. Prohibit all roof traffic upon commencement of the fireproofing and until the fireproofing material is dry.
- F. Protect permanently exposed walls or floors, or special surfaces which are not scheduled to receive fireproofing.

3.3 APPLICATION

- A. Equipment, mixing and application shall be in accordance with the manufacturer's written application instructions.
- B. The application of spray-applied fire resistive material shall not commence until certification has been received by the General Contractor that surfaces to receive sprayed fire protection have been inspected by the applicator and are acceptable to receive sprayed fire protection.
- C. All unsuitable substrates must be identified and made known to the General Contractor and corrected prior to the application of the spray-applied fire resistive material.
- D. Fire protection shall not be applied to steel floor decks prior to the completion of concrete work on that deck, if any.
- E. The application of sprayed fire protection to the underside of roof deck shall not commence until the roof is completely installed and tight, all penthouses are complete, all mechanical units have been placed, and all roof traffic has ceased.
- F. Proper temperature and ventilation shall be maintained as specified herein.
- G. Provide masking, drop cloths or other suitable coverings to prevent overspray from coming in contact with surfaces not intended to be sprayed.

- H. Bonding materials (adhesives, catch coats, metal lath, mesh, stud pins, etc.) shall be applied in accordance with the appropriate UL fire resistance design and manufacturer's written instructions.
- I. Equipment and application procedures for installation of topcoat sealer materials shall conform to the material manufacturer's application instructions.
- J. Post appropriate cautionary "Slippery When Wet" signs in all areas in contact with wet fireproofing material.
- K. Erect appropriate barriers to prevent entry by non-fireproofing workers into the fireproofing spray and mixing areas and other areas exposed to wet fireproofing material.

3.4 INSPECTION AND TESTING

- A. The Owner will select, and pay an independent testing laboratory to randomly sample and verify the thickness and the density of the fireproofing in accordance with one (1) of the following procedures:
 - 1. ASTM E605, Standard Test Method for Thickness and Density of Sprayed Fire-Resistive Materials Applied to Structural Members.
 - 2. AWCI, Standard Practice for the Testing and Inspection of Field-Applied Sprayed Fire-Resistive Materials.
 - 3. UBC Standard No. 7-6, Thickness and Density Determination for Spray-Applied Fire Protection.

3.5 REPAIRING AND CLEANING

- A. All patching of and repair to sprayed fire protection, due to damage by other trades, shall be performed under this Section.
- B. After the completion of the Work in this Section, equipment shall be removed and all surfaces not to be sprayed shall be cleaned to the extent previously agreed to by applicator and General Contractor.
- C. Except as detailed in Paragraph 3.2, F, floors shall be left in a scraped condition.

3.6 FIRE RATING SCHEDULE

- A. As shown on drawings.

END OF SECTION

SECTION 078413.C - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Firestopping systems for the following applications:
 - a. Penetrations, joints, and openings in fire-resistance-rated walls.
 - b. Penetrations, joints, and openings in horizontal assemblies.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference:** Conduct conference at Project site.

1.3 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.**
- B. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.**
- C. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems.**
- D. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.**
- E. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus.**
- F. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies.**
- G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.**
- H. FM 4991 - Approval Standard of Firestop Contractors.**
- I. FM (AG) - FM Approval Guide.**
- J. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems.**
- K. UL (DIR) - Online Certifications Directory**

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Drawings and Specifications do not necessarily indicate everything required for the performance and completion of the Work of this Section. Contractor is responsible for identifying, furnishing, and installing all components necessary for the proper firestopping of fire-rated assemblies in accordance with governing codes, standards, and authorities.
- B. References to specific firestopping assemblies in the Construction Documents are for the sole purpose of communicating design intent to Contractor and local code authorities and do not relieve Contractor of responsibility for properly firestopping penetrations, joints, and openings utilizing indicated assemblies or tested alternates acceptable to the Architect and code authorities.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular firestopping system, submit illustration, with modifications marked, approved by firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each firestopping system, for tests performed by a qualified testing agency.

1.7 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.
- B. Manufacturer's Affidavit: From Manufacturer stating that materials used contain no asbestos.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A firm that has been approved by FM Approval according to FM Approval 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."
- 1. Installer shall specialize in performing the Work of this Section and have minimum 3 years of experience installing tested and classified firestop and fire safing systems or have manufacturer's certification and approval.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install firestopping system when ambient or substrate temperatures are outside limits permitted by firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.10 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate firestopping systems.

1.11 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace firestopping products and assemblies that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.
 - 2. Defects shall include, but not be limited to:
 - a. Use of incorrect material within the installation
 - b. No mineral wool insulation within a system that requires it.
 - c. Use of mineral wool insulation when ceramic fiber insulation is required.
 - d. Incorrect amount of material is installed within system.
 - e. No use of an accessory seal within a system that requires one.
 - f. Installation of an incorrect system
 - g. Failure to meet specified performance or quality assurance requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" and "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."
 - 3) FM Approval in its "Approval Guide."

2.2 MANUFACTURERS

A. Firestopping Manufacturers:

1. Hilti, Inc: www.hilti.com/#sle.

B. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

C. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

D. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

- F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 - 1. Permanent forming/damming/backing materials.
 - 2. Substrate primers.
 - 3. Collars.
 - 4. Steel sleeves.

2.3 JOINT FIRESTOPPING SYSTEMS

- A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
 - 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.
- C. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.
- D. Accessories: Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

2.4 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.
- K. Fire Safing Materials: Comply with ASTM C665, Type I, high-melt mineral-fiber insulation with minimum nominal density of 4.0 lbs. per cubic foot and having a maximum flame spread rating of 15 and smoke developed rating of 0. Size shall be 4 inches thick by 24 inches wide by 48 inches long, unless noted otherwise. Products containing asbestos strictly prohibited.

2.5 MIXING

- A. Firestopping Materials: For those products requiring mixing before application, comply with firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

- A. General: Install firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
- D. Fire Safing Materials:
 - 1. Install fire safing in sufficient thickness, with retainer materials where shown or required to achieve fire rating in accordance with manufacturer's instructions and authorities having jurisdiction.
 - 2. Do not conceal or enclose any fire safing materials until they have been examined and approved for use by the Architect and authorities having jurisdiction.

3.4 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or firestopping system is damaged or removed because of testing, repair or replace firestopping system to comply with requirements.
- C. Proceed with enclosing firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.5 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION

SECTION 079200.C - JOINT SEALANTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nonsag gunnable joint sealants
- B. Self-leveling pourable joint sealants
- C. Joint backings and accessories

1.2 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant, sealant backing, and bond breaker product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
 - 1. Include samples of sealant backing and bond breaker materials.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

- A. Test and Evaluation Reports:
 - 1. Preconstruction Laboratory Test Reports: For each joint sealant and substrate material from sealant manufacturer, indicating the following:
 - a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
 - b. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- B. Warranties: Sample of special warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Warranty Documentation:
 - 1. Manufacturers' special warranties.
 - 2. Installer's special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Exposed sealant work, including sealants used for air and weather seals which are components of the building envelope, shall be performed by a firm specializing in the installation of sealants with a minimum of 5 years of documented experience and which is certified by the manufacturer as qualified to install the materials used.
- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.
- C. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
 - 1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

1.7 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period:
 - a. Five years from date of Substantial Completion for polyurethane sealants.
 - b. Twenty years from date of Substantial Completion for silicone sealants.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Conform to ASTM C1193 requirements for materials and installation.

- C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.
- F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 JOINT SEALANT APPLICATIONS

- A. Scope:
 - 1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to:
 - a. Precast architectural concrete wall panels.
 - b. Wall expansion and control joints.
 - c. Joints between door, window, and other frames and adjacent construction.
 - d. Joints between different exposed materials.
 - e. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed.
 - 2. Interior joints to be sealed include, but are not limited to, the following items:
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 - 1) Exception: Such gaps and openings in gypsum board finished stud walls and suspended ceilings. See Section 092116 for additional information.
 - 2) Exception: Through-penetrations in sound-rated assemblies that are also fire-rated
 - 3. Do not seal the following types of joints:
 - a. Intentional weep holes in masonry.
 - b. Joints indicated to be treated with manufactured expansion joint cover, or some other type of sealing device.
 - c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
 - d. Joints where installation of sealant is specified in another section
- B. Exterior Joints: Use nonsag nonstaining silicone sealant, unless otherwise indicated.
- C. Interior Joints: Use nonsag polyurethane sealant, unless otherwise indicated.
 - 1. In Sound-Rated Assemblies: Acrylic emulsion latex sealant.

2. Other Floor Joints: Self-leveling polyurethane traffic-grade sealant.

D. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.3 JOINT SEALANTS – GENERAL

A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.

2.4 NONSAG JOINT SEALANTS

A. Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.

1. Movement Capability: Plus 100 percent and minus 50 percent, minimum.
2. Nonstaining to Porous Concrete and Stone: Nonstaining to light-colored precast and stone products when tested in accordance with ASTM C1248.
3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
4. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.
5. Color: To be selected by Architect from manufacturer's standard range.
6. Service Temperature Range: Minus 20 to 180 degrees F.
7. Products:
 - a. Tremco Commercial Sealants & Waterproofing; Spectrem 1:
www.tremcosealants.com/#sle.

B. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.

1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
2. Hardness Range: 35 to 45, Shore A, when tested in accordance with ASTM C661.
3. Color: To be selected by Architect from manufacturer's standard range.
4. Service Temperature Range: Minus 40 to 180 degrees F.
5. Products:
 - a. Tremco Commercial Sealants & Waterproofing; Dymonic 100:
www.tremcosealants.com/#sle.

C. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.

1. Color: Standard colors matching finished surfaces, Type OP (opaque).
2. Grade: ASTM C834; Grade 0 Degrees F (Minus 18 Degrees C).
3. Products:
 - a. Master Builders Solutions; MasterSeal NP 520: www.master-builders-solutions.com/en-us/#sle. b. Pecora Corporation; AC-20 +Silicone: www.pecora.com/#sle.
 - b. Tremco Commercial Sealants & Waterproofing; Tremflex 834:
www.tremcosealants.com/#sle.

2.5 SELF-LEVELING JOINT SEALANTS

- A. Semi-Rigid Self-Leveling Epoxy Joint Filler: Epoxy or epoxy/polyurethane copolymer; intended for filling cracks and control joints not subject to significant movement; rigid enough to support concrete edges under traffic.
 - 1. Composition: Multicomponent, 100 percent solids by weight.
 - 2. Durometer Hardness: Minimum of 85 for Type A or 35 for Type D, after seven days when tested in accordance with ASTM D2240.
 - 3. Color: To be selected by Architect from manufacturer's standard colors.
 - 4. Joint Width, Minimum: 1/8 inch.
 - 5. Joint Depth: Provide product suitable for joints from 1/8 inch to 2 inches in depth including space for backer rod.
 - 6. Products:
 - a. Euclid Chemical Company; EUCO 700: www.euclidchemical.com/#sle.

2.6 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type O (open-cell material) or Type B (bicellular material with a surface skin), of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Exterior insulation and finish systems.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
 - a. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 4. Remove excess sealant from surfaces adjacent to joints.
 - 5. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 6. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
 - 7. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
 - 8. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

- F. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

SECTION 081113.C - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes hollow-metal doors and frame assemblies.
- B. Related Sections:
 - 1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.
 - 2. Section 08 81 00 "Glass Glazing" for glass in hollow metal doors and sidelights.
 - 3. Section 09 91 23 "Interior Painting" for field painting primed doors and frames.
 - 4. Section 13 49 00 "Radiation Protection" for lead-lined, hollow-metal doors and frames.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, recycled content, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.

3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Samples for Verification:

1. For "Doors" and "Frames" subparagraphs below, prepare Samples approximately 8 by 10 inches to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

- D. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.
- B. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic or canvas shelters.
 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Inspect doors and frames on delivery for damage. Minor damages may be repaired provided refinished items match new Work and are acceptable to Owner. Discard and replace any damaged items that cannot be repaired to Owner's satisfaction.

- D. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation. If cardboard wrappers on doors become wet, remove cartons immediately.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amweld International, LLC.
 - 2. Ceco Door Products; an Assa Abloy Group company.
 - 3. Curries Company; an Assa Abloy Group company.
 - 4. Republic Doors and Frames.
 - 5. Steelcraft; an Ingersoll-Rand company.
- B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. For exterior doors and mechanical room doors provide assemblies having temperature rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 2. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 INTERIOR DOORS AND FRAMES

- A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2. At all locations unless indicated otherwise.

1. Physical Performance: Level B according to SDI A250.4.
 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated, cold-rolled steel sheet, minimum thickness of 0.042 inch (18 gage).
 - d. Edge Construction: Model 2, Seamless.
 - e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
 3. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch .
 - b. Construction: Face welded.
 4. Exposed Finish: Prime.
- C. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3. At 90-minute-rated stair and building separation doors.
1. Physical Performance: Level A according to SDI A250.4.
 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Metallic-coated, cold-rolled steel sheet, minimum thickness of 0.053 inch .
 - d. Edge Construction: Model 2, Seamless.
 - e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
 3. Frames:
 - a. Materials: Metallic-coated, steel sheet, minimum thickness of 0.053 inch .
 - b. Construction: Face welded.
 4. Exposed Finish: Prime.

2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3.
 1. Physical Performance: Level A according to SDI A250.4.

2. Doors:

- a. Type: As indicated in the Door and Frame Schedule.
- b. Thickness: 1-3/4 inches
- c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch , with minimum A40 coating.
- d. Edge Construction: Model 2, Seamless.
- e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.

- 1) Thermal-Rated Doors: Where indicated in the Door and Frame Schedule, provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

3. Frames:

- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch , with minimum A40 coating.
- b. Construction: Face welded.

4. Exposed Finish: Prime.

2.5 FRAME ANCHORS

A. Jamb Anchors:

- 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
- 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.

2.6 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A1011A/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

- E. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- H. Glazing: Comply with requirements in Section 08 81 00 "Glass Glazing."
- I. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 - 1. Fire Door Cores: As required to provide fire-protection and temperature-rise ratings indicated.
 - 2. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches.
 - 3. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
 - 4. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
 - 5. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 6. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 3. Provide frames with double back-bend returns in metal stud partitions.
 4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
 7. Terminated Stops: At all Operating Room Doors, terminate stops 6 inches above finish floor with a 45 -degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.
- D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

- F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted hairline joints.
1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 4. Provide loose stops and moldings on inside of hollow-metal work.
 5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
 6. The location of glazed lites shall be 9 inches minimum from the latch side edge of door and the bottom shall be 43 inches maximum above the finished floor.

2.8 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Surface Preparation: Solvent-clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond.
 2. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.9 ACCESSORIES

- A. Louvers: Provide louvers for interior doors, where indicated, which comply with SDI 111C, with blades or baffles formed of 0.020-inch- thick (24 gage), cold-rolled steel sheet set into 0.032-inch- thick (20 gage) steel frame.
1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
 2. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link at 150 deg F, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.
- B. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick (26 gage).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11
 - 1. Except for frames in existing walls, place frames before constructing enclosing walls and ceilings.
 - 2. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Conceal fastenings unless otherwise indicated.
 - d. Install frames with removable stops located on secure side of opening.
 - e. Install door silencers in frames before grouting.
 - f. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - g. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

- h. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
 - 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 - 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 - 5. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Steel Doors:
 - a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
 - c. At Bottom of Door: 3/4 inch plus or minus 1/32 inch.
 - d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - 3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 81 00 "Glass Glazing" and with hollow-metal manufacturer's written instructions.
 - 1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
1. Where doors do not meet fit clearances specified, adjust using fire-rated doors seals and astragals.

- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

SECTION 083113.C - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes access doors and frames for walls and ceilings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Detail fabrication and installation of access doors and frames for each type of substrate.
- C. Samples: For each door face material, at least 3 by 5 inches in size, in specified finish.
- D. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.4 QUALITY ASSURANCE

- A. Size Variations: Obtain Owner's acceptance of manufacturer's standard size units wherever they vary from sizes indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are listed and labeled by

UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
2. NFPA 288 for fire-rated access door assemblies installed horizontally.

2.2 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:
1. Babcock-Davis.
 2. J.L. Industries, Inc.; Div. of Activar Construction Products Group.
 3. Karp Associates, Inc.
 4. Larsen's Manufacturing Company.
 5. Milcor Inc.
 6. Nystrom, Inc.
- B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.
- C. Flush Access Doors with Exposed Flanges - ACD-1:
1. Basis-of-Design Product: Nystrom, Inc.; NW Series.
 2. Use: All areas unless noted otherwise.
 3. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 4. Locations: Wall and ceiling.
 5. Door Size: As indicated on Drawings.
 6. Uncoated Steel Sheet for Door: Nominal 0.075 inch, 14 gage.
 - a. Finish: Factory prime.
 7. Frame Material: Same material and finish as door, nominal 0.060 inch (16 gage).
 8. Trim: Hot-dipped galvanized steel sheet gypsum corner bead, nominal 0.034 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Locks; flush, screwdriver-operated cam.
- D. Flush Access Doors with Exposed Flanges - ACD-2:
1. Basis-of-Design Product: Nystrom, Inc.; NT Series.
 2. Use: Wet areas and areas with tile finish.
 3. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 4. Locations: Wall and ceiling.
 5. Door Size: As indicated on Drawings.
 6. Stainless-Steel Sheet for Door: Nominal 0.078 inch (14 gage).
 - a. Finish: No. 4.
 7. Frame Material: Same material and finish as door, nominal 0.062 inch (16 gage).
 8. Trim: Stainless steel gypsum corner bead, nominal 0.031 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Locks; flush, screwdriver-operated cam.

- E. Flush Access Doors with Exposed Flanges - ACD-3:
1. Basis-of-Design Product: Nystrom, Inc.; NW Series.
 2. Use: As indicated on Drawings.
 3. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
 4. Locations: Wall and ceiling.
 5. Door Size: As indicated on Drawings.
 6. Metallic-Coated Steel Sheet for Door: Nominal 0.079 inch (14 gage).
 - a. Finish: Factory prime.
 7. Frame Material: Same material and finish as door, nominal 0.064 inch (16 gage).
 8. Trim: Hot-dipped galvanized steel sheet gypsum corner bead, nominal 0.034 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Locks; flush, screwdriver-operated cam.
- F. Flush Access Doors with Concealed Flanges - ACD-4:
1. Basis-of-Design Product: JL Industries; WB Series.
 2. Use: Operating Room areas and other areas as indicated on Drawings.
 3. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
 4. Locations: Wall and ceiling.
 5. Door Size: As indicated on Drawings.
 6. Stainless-Steel Sheet for Door: Nominal 0.078 inch (14 gage).
 - a. Finish: No. 4.
 7. Frame Material: Same material and finish as door, nominal 0.062 inch (16 gage).
 8. Trim: Stainless steel sheet gypsum board corner bead, nominal 0.031 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Locks; flush, screwdriver-operated cam.
 11. Gasketing: Minimum 1/16-inch x 3/8-inch neoprene gasket around door.
- G. Flush Access Doors with Concealed Flanges - ACD-5:
1. Basis-of-Design Product: JL Industries; Series WB.
 2. Use: As indicated on Drawings.
 3. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
 4. Locations: Wall and ceiling.
 5. Door Size: As indicated on Drawings.
 6. Uncoated Steel Sheet for Door: Nominal 0.075 inch thick (14 gage).
 - a. Finish: Factory prime.
 7. Frame Material: Same material and finish as door, nominal 0.60 inch thick (16 gage).
 8. Trim: Hot-dipped galvanized steel sheet gypsum board corner bead, minimum 0.034 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Locks; flush, screwdriver-operated cam.
- H. Flush Access Doors with Concealed Flanges - ACD-6:
1. Basis-of-Design Product: JL Industries, Series WB.
 2. Use: As indicated on Drawings.

3. Assembly Description: Fabricate door to fit flush to frame. Provide frame with gypsum board beads for concealed flange installation.
 4. Locations: Wall and ceiling.
 5. Door Size: As indicated on Drawings.
 6. Metallic-Coated Steel Sheet for Door: Nominal 0.079 inch (14 gage).
 - a. Finish: Factory prime.
 7. Frame Material: Same material and finish as door, nominal 0.064 inch (16 gage).
 8. Trim: Hot-dipped galvanized steel sheet gypsum board corner bead, nominal 0.034 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Locks; flush, screwdriver-operated cam.
- I. Recessed Access Doors - ACD-7:
1. Basis-of-Design Product: Nystrom, Inc.; RW Series.
 2. Use: Public areas as indicated on Drawings.
 3. Assembly Description: Fabricate door in the form of a pan recessed 5/8 inch for gypsum board infill. Provide frame with gypsum board bead for concealed flange installation.
 4. Locations: Wall and ceiling.
 5. Door Size: As indicated on Drawings.
 6. Uncoated Steel Sheet for Door: Nominal 0.075 inch (14 gage).
 - a. Finish: Factory prime.
 7. Frame Material: Same material and finish as door, nominal 0.060 inch (16 gage).
 8. Trim: Hot-dipped galvanized steel gypsum board corner bead, nominal 0.034 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Locks; flush, screwdriver-operated cam.
- J. Fire-Rated, Flush Access Doors with Exposed Flanges - ACD-8:
1. Basis-of-Design Product: Nystrom, Inc.; IW Series.
 2. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 3. Use: All fire-rated wall or ceiling assemblies, unless indicated otherwise.
 4. Locations: Wall and ceiling.
 5. Fire-Resistance Rating: Not less than that of adjacent construction.
 6. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
 7. Uncoated Steel Sheet for Door: Nominal 0.036 inch (20 gage).
 - a. Finish: Factory prime.
 8. Frame Material: Same material and finish as door, nominal 0.060 inch thick (16 gage).
 9. Trim: Hot-dip galvanized steel sheet gypsum board corner bead, nominal 0.034 inch (22 gage).
 10. Hinges: Concealed continuous piano.
 11. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).
- K. Fire-Rated, Flush Access Doors with Exposed Flanges - ACD-9:
1. Basis-of-Design Product: Nystrom, Inc.; IW Series.

2. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 3. Use: As indicated on Drawings.
 4. Locations: Wall and ceiling.
 5. Fire-Resistance Rating: Not less than that of adjacent construction.
 6. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
 7. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch (20 gage).
 - a. Finish: Factory prime.
 8. Frame Material: Same material and finish as door, nominal 0.064 inch (16 gage).
 9. Trim: Hot-dip galvanized steel sheet gypsum board corner bead, nominal 0.034 inch (22 gage).
 10. Hinges: Concealed continuous piano.
 11. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).
- L. Fire-Rated, Flush Access Doors with Exposed Flanges - ACD-10:
1. Basis-of-Design Product: Nystrom, Inc.; IW Series.
 2. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 3. Use: As indicated on Drawings.
 4. Locations: Wall and ceiling.
 5. Fire-Resistance Rating: Not less than that of adjacent construction.
 6. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
 7. Stainless-Steel Sheet for Door: Nominal 0.038 inch (20 gage).
 - a. Finish: No. 4.
 8. Frame Material: Same material and finish as door, nominal 0.064 inch thick (16 gage).
 9. Trim: Stainless-steel sheet gypsum board corner bead; nominal 0.031 inch (22 gage).
 10. Hinges: Concealed continuous piano.
 11. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).
- M. Fire-Rated, Flush Access Doors with Exposed Flanges - ACD-11:
1. Basis-of-Design Product: Nystrom, Inc.; UT Series.
 2. Assembly Description: Fabricate door to fit flush to frame, uninsulated. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 3. Use: As indicated on Drawings.
 4. Locations: Wall and ceiling.
 5. Fire-Resistance Rating: Not less than that of adjacent construction.
 6. Uncoated Steel Sheet for Door: Nominal 0.036 inch (20 gage).
 - a. Finish: Factory prime.
 7. Frame Material: Same material and finish as door, nominal 0.060 inch thick (16 gage).
 8. Trim: Hot-dip galvanized steel sheet gypsum board corner bead, nominal 0.034 inch (22 gage).

9. Hinges: Concealed continuous piano.
 10. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).
- N. Fire-Rated, Flush Access Doors with Exposed Flanges - ACD-12:
1. Basis-of-Design Product: Nystrom, Inc.; UT Series.
 2. Assembly Description: Fabricate door to fit flush to frame, uninsulated. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 3. Use: As indicated on Drawings.
 4. Locations: Wall and ceiling.
 5. Fire-Resistance Rating: Not less than that of adjacent construction.
 6. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch (20 gage).
 - a. Finish: Factory prime.
 7. Frame Material: Same material and finish as door, nominal 0.064 inch (16 gage).
 8. Trim: Hot-dip galvanized steel sheet gypsum board corner bead, nominal 0.034 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).
- O. Fire-Rated, Flush Access Doors with Exposed Flanges - ACD-13:
1. Basis-of-Design Product: Nystrom, Inc.; UT Series.
 2. Assembly Description: Fabricate door to fit flush to frame, uninsulated. Provide self-latching door with automatic closer and interior latch release. Provide manufacturer's standard-width exposed flange, proportional to door size.
 3. Use: As indicated on Drawings.
 4. Locations: Wall and ceiling.
 5. Fire-Resistance Rating: Not less than that of adjacent construction.
 6. Stainless-Steel Sheet for Door: Nominal 0.038 inch (20 gage).
 - a. Finish: No. 4.
 7. Frame Material: Same material and finish as door, nominal 0.062 inch (16 gage).
 8. Trim: Stainless-steel sheet gypsum board corner bead; minimum 0.031 inch (22 gage).
 9. Hinges: Concealed continuous piano.
 10. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).
- P. Fire-Rated, Flush Access Doors with Concealed Flanges - ACD-14:
1. Basis-of-Design Product: Babcock-Davis; BI Series.
 2. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide frame with gypsum board beads for concealed flange installation.
 3. Use: As indicated on Drawings.
 4. Locations: Wall and ceiling.
 5. Fire-Resistance Rating: Not less than that of adjacent construction.
 6. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
 7. Uncoated Steel Sheet for Door: Nominal 0.036 inch (20 gage).
 - a. Finish: Factory prime.
 8. Frame Material: Same material and finish as door, nominal 0.060 inch (16 gage).

9. Trim: Hot-dipped galvanized steel sheet gypsum board corner bead, nominal 0.034 inch (22 gage).
10. Hinges: Concealed continuous piano.
11. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).

Q. Fire-Rated, Flush Access Doors with Concealed Flanges - ACD-15:

1. Basis-of-Design Product: Babcock-Davis; BI Series.
2. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide frame with gypsum board beads for concealed flange installation.
3. Use: As indicated on Drawings.
4. Locations: Wall and ceiling.
5. Fire-Resistance Rating: Not less than that of adjacent construction.
6. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
7. Metallic-Coated Steel Sheet for Door: Nominal 0.040 inch (20 gage).
 - a. Finish: Factory prime.
8. Frame Material: Same material and finish as door, nominal 0.064 inch (16 gage).
9. Trim: Hot-dipped galvanized steel sheet gypsum board corner bead, nominal 0.034 inch (22 gage).
10. Hinges: Concealed continuous piano.
11. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).

R. Fire-Rated, Flush Access Doors with Concealed Flanges - ACD-16:

1. Basis-of-Design Product: Babcock-Davis; BI Series.
2. Assembly Description: Fabricate door to fit flush to frame, with a core of mineral-fiber insulation enclosed in sheet metal. Provide self-latching door with automatic closer and interior latch release. Provide frame with gypsum board beads for concealed flange installation.
3. Use: As indicated on Drawings.
4. Locations: Wall and ceiling.
5. Fire-Resistance Rating: Not less than that of adjacent construction.
6. Temperature-Rise Rating: 450 deg F at the end of 30 minutes.
7. Stainless-Steel Sheet for Door: Nominal 0.038 inch (20 gage).
 - a. Finish: No. 4.
8. Frame Material: Same material and finish as door, nominal 0.062 inch (16 gage).
9. Trim: Stainless-steel sheet gypsum board corner bead, nominal 0.031 inch (22 gage).
10. Hinges: Concealed continuous piano.
11. Hardware: Latch; bolt-type, operated by either a ring turn or flush key device (keyed alike).

2.3 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- D. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
- E. Frame Anchors: Same type as door face.
- F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
 - 1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
 - 2. Provide mounting holes in frames for attachment of units to metal or wood framing.
 - 3. Provide mounting holes in frame for attachment of masonry anchors.
- D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.
- E. Locking Devices: Furnish number required to hold doors in flush, smooth plane when closed.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Steel and Metallic-Coated-Steel Finishes:
 - 1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
- E. Stainless-Steel Finishes:
 - 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
 - c. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Advise Installers of other Work about specific requirements related to access door installation, including sizes of opening to receive access door and frame, as well as locations of supports, inserts, and anchoring devices.
- B. Furnish inserts and anchoring devices for access doors that must be built into other construction. Coordinate delivery to avoid delay.

3.2 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.4 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 08 31 13

SECTION 083429.C - SPECIALTY SLIDING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sliding side fixed AD System doors

B. Related Sections:

1. Section 09 2216 – Non-Structural Metal Framing: Stud framing supporting sliding doors.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene at project site seven (7) calendar days prior to scheduled start of construction activities of this section and review section requirements.

1. Attendance: Architect, Contractor, partition system installer, and related trades.
2. Review and discuss:
 - a. Critical dimensions.
 - b. Product delivery and storage.
 - c. Staging and sequencing.
 - d. Protection of completed work.

1.3 SUBMITTALS

- A. Shop Drawings: Include plans, elevations, and details showing type and thickness of metal and glass, glazing, anchoring, and joining, hardware, trim, and accessories.
- B. Product Data: Manufacturer's descriptive data and performance characteristics.
- C. Manufacturer's Installation Instructions: Include complete preparation, installation and cleaning requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Partition system shall be installed by manufacturer's personnel.
- B. Mockup:

1. Size: One (1) full door.
2. Show: Framing system, glazing, fittings and hardware.
3. Locate where directed.
4. Approved mockup may remain as part of the Work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project site and store in manufacturer's protective cartons until openings are ready for door installation.
- B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Basis-of-Design: Subject to compliance with requirements, provide the following
 1. Examslide by AD Systems for reading and conference rooms.

2.2 SLIDING DOOR ASSEMBLIES

- A. Top track, side fixed, sliding doors: Specifications are based on ExamSlide Barn Door, with door, suspension system, hardware, and accessories.
- B. Frame Profiles: Extruded aluminum frame "wrap" frame with integral vertical jamb (stile pocket).

2.3 MATERIALS

- A. Door: Wood door as scheduled, with Acrovyn finished.
- B. Opening Frame: Extruded aluminum hollow or C-shaped section, 0.125 inch minimum thickness.
 1. Frame Depth: To fit wall thickness indicated.
 2. Face Width: Nominal 1 1/2 inches.
 3. Finish: Clear anodized.
- C. Hardware and Fittings:
 1. Configuration: Single door panel bypassing on surface of wall opening (barn door).
 2. Sliding Door Header: Track and suspension system concealed with removable cover.

- a. Removable Track Cover: Extruded aluminum with integral end caps.
 - b. Overhead Track: Extruded aluminum, with anti-rising, anti derailing design.
 - c. Door Suspension System: Wheeled carriers with nylon rollers, two per panel, sized to accommodate door weight.
3. Floor Guides: Concealed, integral jamb-mounted.
 4. Closer: Soft close dampening system.
 5. Pull Handles: Manufacturer's standard 16 inch long x 1 inch diameter stainless steel, US32D.
 6. Latch: Privacy set, TAS compliant thumbturn inside with occupancy indicator and custodial override outside, hook bolt lock, US32D finish.
 - a. Provide Elec6 Fail Secure hardware Component for locking and card reader unlocking
 7. Gaskets: Manufacturer's standard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that openings are acceptable.
- B. If substrate preparation is the responsibility of another installer or trade, notify Architect of unsatisfactory or detrimental conditions before proceeding.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings.
- B. Install components plumb and level, in proper plane, free from warp and twist.
- C. Tolerances:
 1. Maximum Variation from Plumb or Level: 1/8 inch in 3 feet or 1/4 inch in 10 feet
 2. Maximum misalignment of members abutting end-to-end: 1/16.

3.3 ADJUSTING

- A. Adjust doors to operate correctly, without binding to frame, sill or adjacent doors.
- B. Adjust door hardware for smooth operation.

END OF SECTION

SECTION 084243.C - INTENSIVE CARE UNIT/CRITICAL CARE UNIT ENTRANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes manually operated ICU/CCU entrances applicable for A.I.I. Room
- B. Related Section:
 - 1. Section 08 42 29 "Automatic Entrances" for entrances packaged with automatic door operators and controls.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for ICU/CCU entrances.
- B. Shop Drawings: For ICU/CCU entrances. Include plans, elevations, sections, details, hardware mounting heights, and attachments to other work.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation and maintenance of units required for this Project.
- B. Source Limitations: Obtain ICU/CCU entrances from single source from single manufacturer.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings to receive ICU/CCU entrances by field measurements before fabrication.

1.7 COORDINATION

- A. Coordinate sizes and locations of recesses in concrete floors for recessed sliding tracks. Concrete, reinforcement, and formwork requirements are specified elsewhere.
- B. Templates: Distribute for doors, frames, and other work specified to be factory prepared for installing ICU/CCU entrances.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of ICU/CCU entrances that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Faulty operation of hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period: Five (5) years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period.
 - 1. Warranty Period: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, at smoke-resistive partitions, provide Horton Automatics; a division of Overhead Door Corporation; Profiler-ICU Smoke Rated Type 310 or comparable product by one of the following:
 - 1. Besam Entrance Solutions; an ASSA ABLOY Group company.
 - 2. Stanley Access Technologies; Division of The Stanley Works.
- B. Basis-of-Design Product: Subject to compliance with requirements, where indicated on Drawings provide Stanley Access Technologies; Division of The Stanley Works; Series 7000TL or comparable product by one of the following:
 - 1. Besam Entrance Solutions; an ASSA ABLOY Group company.

2. Horton Automatics; a division of Overhead Door Corporation.
- C. Basis-of-Design Product: Subject to compliance with requirements, where indicated on Drawings provide Stanley Access Technologies; Division of The Stanley Works; Series 7500 TL or comparable product by one of the following:
 1. Besam Entrance Solutions; an ASSA ABLOY Group company.
 2. Horton Automatics; a division of Overhead Door Corporation.

2.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 2. Sheet and Plate: ASTM B 209.
- B. Sealants and Joint Fillers: As specified in Section 07 92 00 "Joint Sealants."
- C. Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout complying with ASTM C 1107; of consistency suitable for application.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 ICU/CCU ENTRANCE ASSEMBLIES

- A. General: Provide manufacturer's standard factory-glazed ICU/CCU entrances including door leaves, sidelites, framing, headers, carrier assemblies, roller tracks, and accessories required for a complete installation.
- B. Opening-Force Requirement, Sliding: Not more than 5 lbf to fully open door.
- C. ICU/CCU Entrance - Smoke-Tight Door:
 1. Configuration: Single-sliding two-panel door, with one operable leaf and sidelite; with breakaway capability for sliding leaf and sidelite.
 2. Mounting: Between jambs.
 3. Floor Track Configuration: No track across sliding-door opening and at sidelites (trackless).
 4. Finish: Finish framing, door(s), sidelite(s), and header with .
- D. ICU/CCU Entrance - 3-Panel Sliding Door:
 1. Configuration: Single-sliding three-panel door, with one operable leaf and two sidelites; with breakaway capability for sliding leaf and one sidelite.
 2. Mounting: Between jambs.
 3. Floor Track Configuration: No track across sliding-door opening and at sidelites (trackless).
 4. Finish: Finish framing, door(s), sidelite(s), and header with Class I, clear anodic finish.

E. ICU/CCU Entrance - 3-Panel Telescoping Door:

1. Configuration: Single-telescoping three-panel door, with two operable leaves and one sidelite; with breakaway capability for sliding leaves only.
2. Mounting: Between jambs.
3. Floor Track Configuration: No track across sliding-door opening and at sidelites (trackless).
4. Finish: Finish framing, door(s), sidelite(s), and header with Class I, clear anodic finish.

2.4 COMPONENTS

A. Framing Members: Manufacturer's standard extruded aluminum, minimum 0.125 inch thick and reinforced as required to support imposed loads.

1. Nominal Size: 1-3/4 by 4-1/2 inches .
2. Extruded Glazing Stops and Applied Trim: Minimum 0.062-inch wall thickness.

B. Stile and Rail Doors: Manufacturer's standard 1-3/4-inch- thick glazed doors with minimum 0.125-inch- thick, extruded-aluminum tubular stile and rail members. Mechanically fasten corners with reinforcing brackets that are welded, or incorporate concealed tie rods that span full length of top and bottom rails.

1. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets for glazing indicated.
2. Stile Design: Narrow stile; 2-1/8-inch nominal width .
3. Rail Design: 3-1/2-inch nominal height.
4. Muntin Bars: Horizontal tubular rail member for each door; match stile design.

C. Sidelites: Manufacturer's standard 1-3/4-inch- deep sidelites with minimum 0.125-inch- thick, extruded-aluminum tubular stile and rail members matching door design and finish.

1. Glazing Stops and Gaskets: Same materials and design as for stile and rail door.
2. Muntin Bars: Horizontal tubular rail member for each sidelite; match stile design.

D. Glazing: As specified in Section 08 81 00 "Glass Glazing."

E. Headers: Fabricated from minimum 0.125-inch- thick extruded aluminum, and extending full width of ICU/CCU entrance units to conceal carrier assemblies and roller tracks. Provide hinged or removable access panels for service and adjustment. Secure panels to prevent unauthorized access.

1. Capacity: Capable of supporting doors up to 100 lb per leaf over spans up to 14 feet without intermediate supports.
2. Provide sag rods for spans exceeding 14 feet.

F. Carrier Assemblies and Overhead Roller Tracks: Manufacturer's standard carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered, ball-bearing-center steel wheels operating on a continuous roller track or of ball-bearing-center steel wheels operating on a nylon- or delrin-covered, continuous roller track. Support doors from carrier assembly by

cantilever and pivot assembly. Provide minimum of two ball-bearing roller wheels and two antirise rollers for each active leaf.

- G. Concealed Bottom Rollers: Manufacturer's standard.
- H. Brackets and Reinforcements: Manufacturer's standard, high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- I. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

2.5 HARDWARE

- A. General: Provide units in sizes and types recommended by ICU/CCU entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.
- B. Breakaway Hardware: Provide release hardware that allows indicated panels to swing out in direction of egress to full 90 degrees from sliding mode.
 - 1. Maximum Force to Open Panel: 50 lbf.
 - 2. Release Position: Sliding door fully open.
- C. Limit Arm: Provide to control doors in the swing mode.
- D. Pulls: Manufacturer's standard recessed units on both sides of each operable door and surface-mounted, D-shaped pull for each swing-out sidelite.
- E. Manual Flush Bolts: BHMA A156.16, Grade 1, edge mortised, lever-extension type; located at bottom of each swing-out sidelite.
- F. Weather Stripping: Manufacturer's standard replaceable components.
 - 1. Compression Type: ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
 - 2. Sliding Type: AAMA 701, wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.
- G. Weather Sweeps: Manufacturer's standard, nylon brush sweep mounted to underside of door bottom.

2.6 FABRICATION

- A. General: Factory fabricate ICU/CCU entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
 - 1. Fabricate aluminum components before finishing.
 - 2. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, fabricated from stainless steel.
 - a. Where fasteners are subject to loosening or turning out from structural movements or vibration, use self-locking devices.
 - b. Reinforce members as required to receive fastener threads.
 4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- B. Framing: Provide ICU/CCU entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
1. Fabricate tubular and channel frame assemblies with manufacturer's standard welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.
 2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
 3. Form profiles that are straight and free of defects or deformations.
 4. Provide components with concealed fasteners and anchor and connection devices.
 5. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
 6. Provide anchorage and alignment brackets for concealed support of assembly from the building structure.
- C. Doors: Factory fabricated and assembled in profiles indicated. Reinforce as required to support imposed loads and for installing hardware.
- D. Glazing: Fabricate framing with minimum glazing edge clearances for thickness and type of glazing indicated, according to GANA's "Glazing Manual."
- E. Hardware: Factory install hardware to the greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.
1. Provide sliding weather stripping, mortised into door, at perimeter of sliding doors and breakaway sidelites.
- F. Electrical Grounding: Fabricate ICU/CCU entrances to be internally grounded, complying with requirements of authorities having jurisdiction.

2.7 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Apply anodic finishes to formed metal after fabrication unless otherwise indicated.

- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of ICU/CCU entrances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
 - 1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
 - 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous coating.
- B. Install ICU/CCU entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place.
 - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - 2. Set headers, carrier assemblies, tracks, operating brackets, and guides level and true to location with anchorage for permanent support.
- C. Glazing: Install glazing as specified in Section 08 81 00 "Glass Glazing."
- D. Sealants: Comply with requirements in Section 07 92 00 "Joint Sealants" for installing sealants, fillers, and gaskets.
 - 1. Set framing members, floor tracks, and flashings in full sealant bed.
 - 2. Seal perimeter of framing members with sealant.
- E. Grounding: Connect ICU/CCU-entrance, electrical grounding systems to building grounding system as specified in electrical grounding Sections.

3.3 ADJUSTING

- A. Adjust operating hardware and moving parts for smooth and safe operation; lubricate as recommended by manufacturer.
- B. Adjust force to open swing panels.
- C. Test grounding system for compliance with requirements of authorities having jurisdiction.

3.4 CLEANING AND PROTECTION

- A. Clean glass and metal surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
- B. Comply with requirements in Section 08 81 00 "Glass Glazing" for cleaning and protecting glass.

END OF SECTION 084243.C

SECTION 08 7113.C - POWER DOOR OPERATORS

PART 1 - GENERAL

1.1 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.
- B. Activation Device: A control that, when actuated, sends an electrical signal to the door operator to open the door.
- C. Double-Egress (Doors): A pair of doors that simultaneously swing, with the two doors moving in opposite directions with no mullion between them.
- D. Double-Swing (Doors): A pair of doors that swing, with the two doors moving in opposite directions with a mullion between them; each door functioning as a single-swing door.
- E. Safety Device: A control that, to avoid injury, prevents a door from opening or closing.
- F. For automatic door terminology, see [BHMA A156.10][and][BHMA A156.19] for definitions of terms.

1.2 COORDINATION

- A. Coordinate sizes and locations of recesses in concrete floors for recessed control mats that control power door operators. Concrete, reinforcement, and formwork requirements are specified elsewhere.
- B. Templates: Distribute for doors, frames, and other work specified to be factory prepared and reinforced for installing power door operators.
- C. Coordinate hardware for doors with operators to ensure proper size, thickness, hand, function, and finish.
- D. Electrical System Roughing-in: Coordinate layout and installation of power door operators with connections to the following:
 - 1. Power supplies.
 - 2. Access-control system.
 - 3. Remote activation devices.
 - 4. Remote monitoring systems.
- E. Pneumatic System Roughing-in: Coordinate layout and installation of power door operators and power units with compressed-air piping.

PART 2 - PRODUCTS

2.1 FABRICATION

- A. Factory fabricate power door operators to comply with indicated standards.
- B. Form aluminum shapes before finishing.
- C. Fabricate exterior components to drain condensation and water-passing joints within operator enclosure to the exterior.
- D. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match operator.
- E. Provide metal cladding, completely covering visible surfaces before shipment to Project site. Fabricate cladding with concealed fasteners and connection devices, with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion, and with allowance for thermal expansion at exterior doors.

2.2 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying strippable, temporary, protective covering before shipping.
- B. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame preparation and reinforcements, and other conditions affecting performance of power door operators.
- B. Examine roughing-in for electrical systems to verify actual locations of power connections before power door operator installation.
- C. Examine roughing-in for compressed-air piping systems to verify actual locations of piping connections before power door operator installation.

- D. Verify that full-height finger guards are installed at each door with pivot hinges, where door has a clearance at hinge side greater than 1/4 inch and less than 3/4 inch with door in any position.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install power door operators in accordance with manufacturer's written instructions and cited BHMA standard for type of door operation and direction of pedestrian travel, including signage, controls, wiring, remote power units if any, and connection to building's power supply.
 - 1. Do not install damaged components. Fit joints to produce hairline joints free of burrs and distortion.
 - 2. Install operators true in alignment with established lines and door geometry without warp or rack. Anchor securely in place.
- B. Controls: Install activation and safety devices in accordance with manufacturer's written instructions and cited BHMA standard for operator type and direction of pedestrian travel. Connect control wiring in accordance with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Access-Control System: Connect operators to access-control system as specified in Section 28 1500 "Access Control Hardware Devices."
- D. Signage: Apply on both sides of each door as required by cited BHMA standard for type of door operator and direction of pedestrian travel.

3.3 ADJUSTING

- A. Adjust power door operators to function smoothly, and lubricate as recommended by manufacturer; comply with requirements of applicable BHMA standards.
 - 1. Adjust operators on exterior doors for tight closure.
- B. After completing installation of power door operators, inspect exposed finishes on doors and operators. Repair damaged finish to match original finish.
- C. Readjust power door operators and controls after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles).
- D. Occupancy Adjustment: When requested within [12]<Insert number> months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two]<Insert number> visits to Project during other-than-normal occupancy hours for this purpose.

3.4 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of power door operator Installer. Include **monthly** preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Engage a Certified Inspector to perform safety inspection after each adjustment or repair and at end of maintenance period. Furnish completed inspection reports to Owner.
 - 2. Perform maintenance, including emergency callback service, during normal working hours.
 - 3. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power door operators.

END OF SECTION

SECTION 088100.C - GLASS GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Windows.
 - 2. Doors.
 - 3. Mirrors.
- B. Related Sections:
 - 1. Section 08 42 29 "Automatic Entrances."
 - 2. Section 10 28 00 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
2. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.6 ACTION SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated, including printed statement of VOC content for glazing sealants used inside the weatherproofing system.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
- C. Glazing Accessory Samples: For gaskets sealants and colored spacers, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers and sealant testing agency.
- B. Product Certificates: For glass and glazing products, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for coated glass insulating glass glazing sealants and glazing gaskets.
 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Warranties: Sample of special warranties.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who have completed glazing installations similar in material, design, and extent to that indicated for this project; whose work has resulted in glass installations with a record of successful in-service performance; and who are certified under the National Glass Association's Certified Glass Installer Program.

- B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Source Limitations for Glass: Obtain ultraclear float glass tinted float glass coated float glass laminated glass and insulating glass from single source from single manufacturer for each glass type.
- E. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
- F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA's "Laminated Glazing Reference Manual," GANA's "Glazing Manual," And GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- G. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- H. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.
- I. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- J. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Install glazing in mockups specified in Section 08 41 13 "Aluminum-Framed Entrances and Storefronts" and Section 08 51 13 "Aluminum Windows" - to match glazing systems required for Project, including glazing methods.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- K. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F.

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: Ten (10) years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: Five (5) years from date of Substantial Completion.
- C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: Ten (10) years from date of Substantial Completion.
- D. Manufacturer's Special Warranty on Mirror Glass: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Confirm glass thicknesses by analyzing Project loads and in-service conditions.
 1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm (1/4 inch).
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
- C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

- A. Fully Tempered Heat-Treated Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
 1. For uncoated glass, comply with requirements for Condition A.

2.3 LAMINATED GLASS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 1. AFG Industries, Inc.
 2. Guardian Industries Corp.
 3. Pilkington North America.
 4. PPG Industries.
 5. Saint-Gobain Glass.

- B. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 - 1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written recommendations.
 - 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 - 3. Interlayer Color: Clear unless otherwise indicated.

2.4 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
- B. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass products); FireLite Plus.
 - b. Vetrotech Saint-Gobain; SGG Keralite FR-L.

2.5 SILVERED FLAT GLASS MIRRORS

- A. Glass Mirrors, General: ASTM C 1503.
 - 1. Manufacturers:
 - a. Gardner Glass, Inc.
 - b. Guardian Industries.
 - c. Lenoir Mirror Company.
 - d. Stroupe Mirror Company, Inc.
 - e. Virginia Mirror Company, Inc.
- B. Tempered Clear Glass: Mirror Glazing Quality, for blemish requirements; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.
 - 1. Nominal Thickness: 6.0 mm (1/4 inch).

2.6 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. Low-Emitting Materials:
 - a. Interior Sealants: All sealants and sealant primers used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) shall comply with South Coast Air Quality Management District (SCAQMD) Rule #1168 effective date of July 1, 2005 and rule amendment date of January 7, 2005.
 - 1) Sealants shall contain no carcinogen or reproductive toxicant components present at more than 1 percent of total mass of the product as defined in the California Office of Environmental Health Hazard Assessment's (OEHHA) list entitled "Chemicals Known to the State to Cause Cancer" or the Reproductive Toxicity, Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65).
 - b. Exterior Sealants: Sealants used on the exterior of the building - defined as from the weatherproofing system out and applied on-site - shall comply with the VOC limits of California Air Resources Board (ARB) 2007 Suggested Control Measure (SCM) for Architectural Coatings and South Coast Air Quality management District (SCAQMD) Rule 1168 effective July 1, 2005.
 4. Colors of Exposed Glazing Sealants: As selected by Owner from manufacturer's standard range.
- B. Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 999-A.
 - b. GE Advanced Materials - Silicones; Contractors SCS1000 or Construction SCS1200.
- C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.7 GLAZING TAPES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or an approved equal manufacturer:
1. Pecora Corp.
 2. Tremco, Inc.
- B. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- C. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.
- H. Mirror Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- I. Mirror Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- J. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrate on which mirrors will be installed.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Laurence, C.R. Co., Inc.
 - b. OSI Sealants, Inc.
 - c. Palmer Products Corporation.
 - d. Pecora Corporation.
- K. Mirror Hardware:
 1. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
 - a. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.05 inch.

- 1) Products: Subject to compliance with requirements, provide the following product or approved equal:
 - a) Laurence, C.R. Co., Inc.; CRL Standard "J" Channel.
 - b. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.062 inch.
 - 1) Products: Subject to compliance with requirements, provide the following product or approved equal:
 - a) Laurence, C.R. Co., Inc.; CRL Deep "J" Channel.
2. Finish: Clear anodized.
3. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
4. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shielded expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for application on inside face of exterior walls and where indicated.

2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

2.10 FABRICATION OF MIRRORS

- A. Mirror Sizes: To suit Project conditions, and before tempering, cut mirrors to final sizes and shapes.
- B. Cutouts: Fabricate cutouts before tempering for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.
- C. Mirror Edge Treatment: Flat polished.
 1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
 2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 2. Presence and functioning of weep systems.
 3. Minimum required face and edge clearances.

4. Effective sealing between joints of glass-framing members.
- B. Examine substrates over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.
- C. Verify compatibility with and suitability of mirror substrates, including compatibility of mirror mastic with existing finishes or primers.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.
- C. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
 1. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated on manufacturer's label.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 MIRROR INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
- B. Provide a minimum air space of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 - 1. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.
 - 2. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips so they are symmetrically placed and evenly spaced.
 - 3. Install mastic as follows:

- a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
- b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
- c. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch between back of mirrors and mounting surface.

3.5 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

3.6 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

- E. Install gaskets so they protrude past face of glazing stops.

3.7 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass. Install pressurized gaskets to protrude slightly out of channel to eliminate dirt and moisture pockets.

3.8 LOCK-STRIP GASKET GLAZING

- A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

3.9 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. Do not permit edges of mirrors to be exposed to standing water.
- F. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088100.C

SECTION 08 9119.C - FIXED LOUVERS

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing in accordance with AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing in accordance with AMCA 540.

1.2 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.

- B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
- D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
 - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern
 - 2. Horizontal Mullions: Provide horizontal mullions at joints
- C. Maintain equal louver blade spacing to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.
 - 1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
 - 2. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades, so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
 - 3. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
 - 4. Exterior Corners: Prefabricated corner units with mitered [**and welded blades**] [**blades with concealed close-fitting splices**] and with mullions at corners.

- G. Provide for recessed louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 9200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 092216.C - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 DELIVERY, STORAGE, AND HANDLING

- A. Notify manufacturer of damaged materials received prior to installation.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling as required by AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, in accordance with ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, in accordance with ASTM E90 and classified in accordance with ASTM E413 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to **1/240** of the wall height based on horizontal loading of 10 lbf/sq. ft.
- D. Design framing systems in accordance with AISI S220, "North American Specification for the Design of Cold-Formed Steel Framing - Nonstructural Members," unless otherwise indicated.
- E. Design Loads: As indicated on architectural Drawings or 5 lbf/sq. ft. minimum as required by the IBC.
- F. Design framing systems to accommodate deflection of primary building structure and construction tolerances and to withstand design loads with a maximum deflection of **<Insert inches>**.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 - 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling tracks to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
 - 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C841 that apply to framing installation.
 - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C1063 that apply to framing installation.
 - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C844 that apply to framing installation.
 - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

END OF SECTION

SECTION 09 2900.C - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Acoustical insulation for sound rated partitions.

B. Related Requirements:

1. Section 09 2216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
2. Section 09 3000 "Tiling" for tile backing panels installed as substrates for ceramic tile.
3. Section 09 9000 "Painting and Coating" for primers applied to gypsum board surfaces.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 QUALITY ASSURANCE

A. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Install mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - b. Each texture finish indicated.
2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. Interior gypsum wallboard and ceiling board installation may not commence until all exterior dampproofing and roofing are completed and roof top equipment is fully installed, flashed and in operation, and exterior wall openings are protected (close-in).

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CertainTeed Corp.
 - 2. Georgia-Pacific Gypsum LLC.
 - 3. National Gypsum Company.
 - 4. USG Corporation.

2.4 ACCESSORIES

- A. Manufacturer: Fry Reglet Corporation
- B. Finish: Standard Anodized Finish, Architectural 200R1 medium etch (AA-M32c10A21), clear color.
- C. Wall Reveals, DRM:
 - 1. Materials: Extruded aluminum
 - 2. Dimensions: As indicated on drawings
 - 3. Install with pre-fabricated inside, outside and intersection pieces
- D. Flush Metal Base, DRMBFL625400:
 - 1. Material: Extruded Aluminum
 - 2. Dimensions: Custom 6" high
 - 3. Radius: As indicated on Drawings

2.5 SPECIALTY GYPSUM BOARD

- A. Tile Backing Panels: As specified in Section 09 3000 "Tiling."

2.6 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - e. Expansion (control) joint.
 - f. Curved-Edge Cornerbead: With notched or flexible flanges.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fry Reglet Corp.
 - b. Gordon, Inc.
 - c. Pittcon Industries.
 - 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
 - 3. Embedded Trim Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.
 - 4. Exposed Trim Finish: Class II clear anodized.

2.7 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
 - 5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

2.8 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Acoustical Insulation: ASTM C 665, Type I; preformed batt; friction fit, for interior walls, conforming to the following:
 - 1. Material: Inorganic Glass Fiber with acrylic resin binder or Mineral Wool
 - 2. Flame Spread Index: 25 or less, when tested in accordance with ASTM E 84.
 - 3. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E 84.
 - 4. Acoustical Performance:
 - a. NRC: 1.05 for 3.5 inch thickness.
 - b. STC: 49 minimum, installed in 3-5/8 metal stud wall with 5/8 inch gypsum board on each side.
 - 5. Facing: Unfaced.
 - 6. Manufacturers:
 - a. CertainTeed Corporation; CertaPro AcoustaTherm: www.certainteed.com.

- b. Johns Manville Corporation; Sound Control Batts: www.jm.com.
 - c. Knauf Insulation; QuietTherm QT: www.knaufinsulation.us.
 - d. Owens Corning Corp; QuietZone Acoustic Batts: www.owenscorning.com
 - e. Thermafiber SAFB: www.thermafiber.com
- D. Thermal Insulation: As specified in Section 07 2100 "Thermal Insulation."
- E. Acoustical Joint Sealant: As specified in Section 07 9200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.

2. Fit gypsum panels around ducts, pipes, and conduits.
 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels horizontally or vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

B. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
 4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- C. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING TILE BACKING PANELS

- A. Refer to Division 9 Section Tiling for board installation.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
1. Cornerbead: Use at outside corners.
 2. LC-Bead: Use at exposed panel edges.
 3. L-Bead: Use where indicated.
 4. U-Bead: Use where indicated.
 5. Curved-Edge Cornerbead: Use at curved openings.
- D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

- B. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- C. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - 3. Level 5: Where indicated on Drawings.

3.7 PARTITION MARKINGS

- A. Mark fire-rated partitions and smoke barriers with 2-inch-high upper case letters stenciled in red paint.
- B. Place markings 6-inches above ceilings both sides of partitions as follows:
 - 1. Centered over doors.
 - 2. Maximum 10 feet on center.
 - 3. Lettering Copy (as applicable):
 - a. "1-HOUR FIRE RATED-PROTECT ALL OPENINGS"
 - b. "2-HOUR FIRE RATED-PROTECT ALL OPENINGS"
 - c. "SMOKE BARRIER, _# -HOUR FIRE RATED-PROTECT ALL OPENINGS" (with appropriate fire rating)
- C. Mark point of partition type demarcation with 1 inch wide painted vertical line from ceiling line to bottom of structure at the following conditions:
 - 1. From rated partition type to non-rated partition type;
 - 2. From change in partition type rating.

3.8 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 095113.C - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.

1.2 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- C. Samples for Initial Selection: For components with factory-applied color finishes.
- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Panel: Set of 6-inch- square Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Sample Set of each type, finish, and color.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full-size panels equal to 5 percent of quantity installed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Suspended Acoustical Tile Ceiling System: Obtain each type of acoustical ceiling tile and its suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.

2. Smoke-Developed Index: 50 or less.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.3 ACOUSTICAL PANELS, GENERAL

- A. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- B. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- C. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance unless otherwise indicated.
 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- D. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.4 ACOUSTICAL PANELS (ACT1, ACT2)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Armstrong World Industries, Inc.
 2. CertainTeed Corp.
 3. USG Interiors, Inc.
- B. Acoustical Panels: ASTM E 1264, Types as indicated, from the following:
 1. Type III, mineral base with painted finish.
 2. Type IV, mineral base with membrane-faced overlay.
 3. Type XII, glass-fiber base with membrane-faced overlay. Binder shall not contain urea formaldehyde.
 4. Type XX, high-density, ceramic- and mineral-base panels with scrubbable finish, resistant to heat, moisture, and corrosive fumes.

- C. Refer to Interior Finish Schedule.

2.5 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled expansion anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
 - d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.
 2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
 3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
 4. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- diameter wire.

2.6 METAL SUSPENSION SYSTEM (ACT1, ACT2)

- A. Manufacturers:

1. Same as for acoustical units.
- B. Ceiling Grids: Types as indicated, from the following:
 1. Wide Face Suspension System: Formed cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished metal cap on flanges; intermediate-duty.
 - a. Profile: Tee, 15/16 inch wide face.
 - b. Construction: Double web.
 - c. Finish: White painted, unless indicated otherwise.
 - d. Basis-of-Design: Prelude XL manufactured by Armstrong.
 2. Aluminum Wide Face Suspension System: Formed aluminum sheet, prepainted; with prefinished aluminum cap on flanges; light-duty.
 - a. Profile: Tee, 15/16 inch wide face.
 - b. Construction: Double web.
 - c. Finish: White painted, unless indicated otherwise.
 - d. Basis-of-Design: Prelude Plus XL manufactured by Armstrong.
 3. Co-Extruded Aluminum (Gasketed) Suspension System: Formed cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished metal cap on flanges; clear hold down clips.
 - a. Profile: Tee, 15/16 inch wide face.
 - b. Construction: Double web.
 - c. Finish: White painted, unless indicated otherwise.
 - d. Basis-of-Design: Clean Room manufactured by Armstrong.
- C. Refer to Interior Finish Schedule.

2.7 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Subject to compliance with requirements, provide products by the suspension system manufacturer or one of the following:
 1. Fry Reglet Corporation.
 2. Gordon, Inc.
 3. Rockfon.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, suspension system manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
 1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.

2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

2.8 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Section 07 9200 "Joint Sealants".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required and to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 096513.C - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermoplastic-rubber base.
 - 2. Rubber molding accessories.
- B. Vinyl molding accessories

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.
- D. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F in spaces to receive resilient products during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC-RUBBER BASE (RB1)

- A. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Style A, Straight: Provide in areas with carpet.
 - b. Style B, Cove: Provide in areas with resilient floor coverings.
 - c. Profile: As specified. Refer to Interior Finish Schedule.
- B. Height: As specified. Refer to Interior Finish Material Legend.
- C. Lengths: Coils in manufacturer's standard length.
- A. Outside Corners: Job formed.
- B. Inside Corners: Job formed.
- C. Colors: As specified. Refer to Interior Finish Schedule.

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

- C. Metal Edge Strips: As specified. Height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

- E. Do not stretch resilient base during installation.
- F. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.
 - a. Miter or cope corners to minimize open joints.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

SECTION 096516.C - RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Backed vinyl sheet flooring.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of flooring. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

1. Show details of special patterns.

C. Samples: For each exposed product and for each color and texture specified in manufacturer's standard size, but not less than 6-by-9-inch sections.

1. For heat-welding bead, manufacturer's standard-size Samples, but not less than 9 inches long, of each color required.

1.3 INFORMATIONAL SUBMITTALS

A. Product test reports.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for resilient sheet flooring installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by resilient sheet flooring manufacturer for installation techniques required.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient sheet flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by the manufacturer. Store rolls upright.

1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, in spaces to receive resilient sheet flooring during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during resilient sheet flooring installation.
- D. Close spaces to traffic for 48 hours after resilient sheet flooring installation.
- E. Install resilient sheet flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 BACKED VINYL SHEET FLOORING (RS1)

- A. Manufacturers: Subject to compliance with requirements, provide products listed on Finish Schedule, or comparable.
- B. Product Standard: ASTM F 1303.
- C. Backing: Non-woven polyester/cellulose glass fiber reinforcement scrim.
- D. Thickness: 0.080 inch.

- E. Wearing Surface: Smooth.
- F. Sheet Width: As standard with manufacturer.
- G. Seamless-Installation Method: Heat welded.
- H. Colors and Patterns: As scheduled.

2.3 BACKED VINYL SHEET FLOORING (RS2)

- A. Manufacturers: Subject to compliance with requirements, provide products listed on Finish Schedule, or comparable.
- B. Product Standard: ASTM F 1303.
- C. Backing: Compact PVC backing.
- D. Thickness: 0.080 inch.
- E. Wearing Surface: Smooth.
- F. Sheet Width: As standard with manufacturer.
- G. Seamless-Installation Method: Heat welded.
- H. Colors and Patterns: As scheduled.
- I. Refer to Interior Finish Schedule

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: As specified in Section 09 0561 "Common Work Results for Flooring Preparation."
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit resilient sheet flooring and substrate conditions indicated; maximum VOC of 50 g/L
- C. Seamless-Installation Accessories:
 - 1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.
 - a. Color: Match flooring.
- D. Integral-Flash-Cove-Base Accessories:
 - 1. Cove Strip: 1-inch radius provided or approved by resilient sheet flooring manufacturer.
 - 2. Cap Strip: Square metal, vinyl, or rubber cap provided or approved by resilient sheet flooring manufacturer.

3. Corners: Metal inside and outside corners and end stops provided or approved by resilient sheet flooring manufacturer.
- E. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient sheet flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare and test concrete substrates in accordance with Section 09 0561 "Common Work Results for Flooring Preparation" and the following:
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.
 3. Verify that substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 4. Verify that substrate moisture vapor emission and internal relative humidity values are within flooring manufacturer's written recommendations.
 5. Fill cracks, holes, and depressions in substrates and remove bumps and ridges to produce a uniform and smooth substrate.
 6. Do not install flooring until it is the same temperature as the space where it is to be installed.
 - a. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
 7. Immediately before installation, sweep and vacuum clean substrates to be covered by flooring.

3.3 RESILIENT SHEET FLOORING INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient sheet flooring.

- B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.
 - C. Lay out resilient sheet flooring as follows:
 - 1. Maintain uniformity of flooring direction.
 - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
 - 3. Match edges of flooring for color shading at seams.
 - 4. Avoid cross seams.
 - D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, and door frames.
 - E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.
 - F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.
 - G. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
 - H. Seamless Installation:
 - 1. Heat-Welded Seams: Comply with ASTM F 1516. Rout joints and heat weld with welding bead to permanently fuse sections into a seamless flooring. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
 - I. Integral-Flash-Cove Base: Cove resilient sheet flooring to dimension indicated up vertical surfaces. Support flooring at horizontal and vertical junction with cove strip. Butt at top against cap strip.
 - 1. Install metal corners at inside and outside corners.
- 3.4 CLEANING AND PROTECTION
- A. Comply with manufacturer's written instructions for cleaning and protecting resilient sheet flooring.
 - B. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.
 - 1. Apply two coats.
 - C. Cover resilient sheet flooring until Substantial Completion.

END OF SECTION

SECTION 096519.C - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Resilient Tile Flooring

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: For each type of resilient floor tile.

1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
2. Show details of special patterns.

- C. Samples for Verification: Full-size units of each color and pattern of floor tile required.

- D. Product Schedule: For floor tile.

1.4 INFORMATION SUBMITTALS

- A. Qualification Data: For Installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 HOMOGENEOUS FLOOR TILE (RT1)

- A. Tile Standard: ASTM F1700, Class I, Type 3.
- B. Wearing Surface: 0.8 inch wear layer.
- C. Thickness: 2.0mm.
- D. Size: As specified.
- E. Colors and Patterns: As specified.
- F. Refer to Interior Finish Schedule

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.

2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- E. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- F. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 1. Lay tiles in pattern indicated on drawings.
- C. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- D. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

- E. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- F. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from soil, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

END OF SECTION

SECTION 096536.C - STATIC-CONTROL RESILIENT FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Static-control, solid vinyl floor tile.

- B. Related Requirements:

- 1. Section 096513 "Resilient Base and Accessories" for resilient base, reducer strips, and other accessories installed with static-control resilient flooring.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of static-control resilient flooring. Include floor-covering layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
- C. Samples: For each type of static-control resilient flooring and in each color, pattern, and texture required, in manufacturer's standard size, but not less than 6 by 9 inches.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For static-control resilient flooring, for tests performed by a qualified testing agency.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of static-control resilient flooring to include in maintenance manuals.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of static-control resilient flooring to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Tile: Furnish one box for every 50 boxes, or fraction thereof, of each type, color, and pattern of floor tile installed.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in installation techniques required by manufacturer for specified static-control resilient flooring.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required for specified products.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store static-control resilient flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended in writing by manufacturer, but not less than 50 deg F or more than 90 deg F.
 - 1. Floor Tile: Store on flat surfaces.

1.10 PROJECT CONDITIONS

- A. Maintain ambient temperatures in spaces to receive static-control resilient flooring within range recommended by manufacturer, but not less than 70 deg F or more than 85 deg F, during the following time periods:
 - 1. Period recommended in writing by manufacturer before installation.
 - 2. During installation.
 - 3. Period recommended in writing by manufacturer after installation.
- B. Until Substantial Completion, maintain ambient temperatures in installation areas within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during static-control resilient flooring installation.

- D. Close spaces to traffic for period recommended in writing by manufacturer after static-control resilient flooring installation.
- E. Install static-control resilient flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 STATIC-CONTROL, SOLID VINYL FLOOR TILE

- A. Source Limitations: Obtain floor tile from single source from single manufacturer.
- B. Static-Control Properties: As determined by testing identical products in accordance with test method indicated by an independent testing and inspecting agency.
 - 1. Electrical Resistance:
 - a. Material: Point-to-point and point-to-ground resistances between $1 \times 10^6 \Omega$ - $1 \times 10^9 \Omega$ (1 M Ω - 1,000 M Ω) when tested in accordance with ASTM F150.
 - 2. Static Generation:
 - a. AATCC TM134: Less than 20 V when tested at 20 percent relative humidity with static-control footwear.
 - 3. Static Decay: 0.01 seconds when tested in accordance with FED-STD-101C, Method 4046.1.
- C. Construction: ASTM F1700, Class I (monolithic), Type A (smooth surface).
- D. Thickness and Size: As specified.
- E. Colors and Patterns: As selected by Architect from manufacturer's full range.
- F. Maintenance Floor Tiles: Special floor tiles inscribed "Conductive floor. Do not wax."

2.2 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified portland cement or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
- B. Static-Control Adhesive: Provided or approved by manufacturer; type that maintains electrical continuity of floor-covering system to ground connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for conditions affecting performance of the Work.
- B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with installation or static-control characteristics of floor coverings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates in accordance with manufacturer's written instructions to ensure successful installation of static-control resilient flooring and electrical continuity of floor-covering systems.
- B. Concrete Substrates: Prepare in accordance with ASTM F710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with floor-covering adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended in writing by manufacturer. Proceed with installation only after substrate alkalinity is not less than [6] <Insert number> or more than [8] <Insert number> pH unless otherwise recommended in writing by flooring manufacturer.
 - 4. Moisture Testing: Perform tests so that each test area does not exceed [200 sq. ft.] [1000 sq. ft.] <Insert area>, and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of [3 lb of water/1000 sq. ft.] <Insert value> in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum [75] <Insert number> percent relative humidity level measurement.
- C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

- E. Do not install static-control resilient flooring until it is same temperature as space where it is to be installed.
 - 1. Move static-control resilient flooring and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- F. Sweep and vacuum substrates to be covered by static-control resilient flooring immediately before installation.

3.3 INSTALLATION, GENERAL

- A. Install static-control resilient flooring in accordance with manufacturer's written instructions.
- B. Extend grounding strips beyond perimeter of static-control resilient floor-covering surfaces to ground connections.
 - 1. For adhesively installed flooring, embed grounding strips in static-control adhesive.
- C. Scribe, cut, and fit static-control resilient flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
 - 1. Extend static-control resilient flooring below built-in items and permanent, but movable, items that allow for a flexible layout where indicated on Drawings.
- D. Extend static-control resilient flooring into toe spaces, door reveals, closets, and similar openings.
- E. Extend static-control resilient flooring to center of door openings where flooring or color transitions occur.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on static-control resilient flooring as marked on substrates. Use chalk or other nonpermanent, nonstaining marking device.
- G. Install static-control resilient flooring on covers for telephone and electrical ducts, and similar items in installation areas. Maintain overall continuity of color and pattern with pieces of static-control resilient flooring installed on covers. Tightly adhere static-control resilient flooring edges to substrates that abut covers and to cover perimeters.
- H. Free-Lay Installation: Install static-control resilient flooring in accordance with manufacturer's written instructions for a completed installation without open cracks, raising and puckering at joints, and surface imperfections.
- I. Adhesive Installation: Adhere static-control resilient flooring to substrates using a full spread of static-control adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protection of static-control resilient flooring.
- B. Perform the following operations immediately after completing static-control resilient flooring:
 - 1. Remove static-control adhesive from exposed surfaces.
 - 2. Remove dirt and blemishes from exposed surfaces.
 - 3. Sweep and vacuum surfaces thoroughly.
 - 4. Damp-mop surfaces to remove marks and soil.
- C. Protect static-control resilient flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
 - 1. Do not wax static-control resilient flooring.
 - 2. If recommended in writing by manufacturer, apply protective static-control floor polish formulated to maintain or enhance floor covering's electrical properties. Before polishing, do the following:
 - a. Ensure that static-control resilient flooring surfaces are free from soil, static-control adhesive, and surface blemishes.
 - b. Verify that both floor polish and its application method are approved by manufacturer and that floor polish will not leave an insulating film that reduces static-control resilient flooring's effectiveness for static control.
- D. Cover static-control resilient flooring and protect from rolling loads until Substantial Completion.

END OF SECTION

SECTION 099123.C - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.3 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Source Limitations for Paint Systems: Obtain each type of paint and primer from single source from single manufacturer.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Benjamine Moore Paint
 - 2. PPG Industries
 - 3. Sherwin Williams

2.3 PAINT, GENERAL

- A. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. Colors: Exactly match architects selected colors. Refer to Interior Finish Schedule (includes deep tones).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Fiber-Cement Board: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 INSTALLATION

- A. Apply paints according to manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed in equipment rooms:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Tanks that do not have factory-applied final finishes.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 2. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - g. Other items as directed by Architect.
 3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 3. Allow empty paint cans to dry before disposal.
 4. Collect waste paint by type and deliver to recycling or collection facility.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Substrates: Gypsum Board

1. Latex over Latex Sealer System, Zero VOC, Eggshell
 - a. Primer: Interior, latex
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex.
2. Latex over Latex Sealer System, Deep Tones, Low VOC, Eggshell
 - a. Primer: Interior, latex
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex.
3. High-Performance Architectural Latex System, Semi-Gloss
 - a. Primer: Interior, latex.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, epoxy, high-performance architectural coating.

B. Substrate: Hollow Metal

1. Latex over Latex Sealer System, Zero VOC, Semi-Gloss
 - a. Primer: Interior, latex
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex.
2. Latex over Latex Sealer System, Deep Tones, Low VOC, Semi-Gloss
 - a. Primer: Interior, latex
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, latex.

3. High-Performance Architectural Latex System, Semi-Gloss
 - a. Primer: Interior, latex.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Interior, epoxy, high-performance architectural coating.
- 4.

END OF SECTION

SECTION 102600.C - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
 - 2. Keep plastic materials out of direct sunlight.
 - 3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.
 - a. Store corner-guard covers in a vertical position.
 - b. Store covers in a horizontal position.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products **of each type** from single source from single manufacturer.
- B. Refer to Interior Finish Schedule for Basis of Design types and locations.
- C. Refer to Interior Finish Plans for applicable locations and quantities.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.

- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1

2.3 MATERIALS

- A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.
- B. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or Class 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft.-lbf/in. of notch when tested according to ASTM D 256, Test Method A.
- C. Solid Wood: Clear hardwood lumber of species indicated, free of appearance defects, and selected for compatible grain and color.
- D. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- E. Adhesive: As recommended by protection product manufacturer.

2.4 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Curved Panels: Preform curved semirigid, abuse-resistant sheet wall covering in factory for radius and sheet thickness as follows:
 - 1. Sheet Thickness of 0.040 Inch: 24-inch radius.
 - 2. Sheet Thickness of 0.060 Inch: 36-inch radius.

Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

- C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.
- D. Wood Handrails: Miter corners and ends of wood handrails for returns.

2.5 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
 - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
 - 2. Where splices occur in horizontal runs of more than 20 feet, splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches apart.
 - 3. Adjust [**end**] [**and**] [**top**] caps as required to ensure tight seams.
- C. Fire Doors: Install protection according to the listing of each item.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION

SECTION 102800.C - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Toilet room accessories.
 - 2. Underlavatory guards.
- B. Owner-Furnished Material: As scheduled on Drawings; all Owner-furnished items are to be installed by Contractor.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:
 - 1. Construction details and dimensions.
 - 2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Material and finish descriptions.
 - 4. Features that will be included for Project.
 - 5. Manufacturer's warranty.
- B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.
 - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify products using designations indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.7 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Substantial Completion.
- B. Special Hand Dryer Warranty: Manufacturer's standard form in which manufacturer agrees to replace dryers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Structural Performance: Design accessories and fasteners to comply with the following requirements:
 - 1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

2.2 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.
- C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- I. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.3 TOILET ROOM ACCESSORIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products scheduled on Drawings or comparable products by one of the following:
 - 1. A & J Washroom Accessories, Inc.
 - 2. American Specialties, Inc.
 - 3. Bobrick Washroom Equipment, Inc.
 - 4. Bradley Corporation.
- B. Finishes: Satin Stainless Steel, unless noted otherwise.
- C. Refer to Equipment Schedule.

2.4 UNDERLAVATORY GUARDS

- A. Underlavatory Guards: As scheduled on Drawings.

2.5 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.
- C. Shower Seats: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION

SECTION 104413.C - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire protection cabinets for the following:
 - a. Portable fire extinguishers.

B. Related Sections:

1. Section 10 4416 "Fire Extinguishers."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.

1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.

B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

C. Samples for Initial Selection: For each type of fire protection cabinet indicated.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Size: 6 by 6 inches square.

E. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

1.3 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire protection cabinets including, but not limited to, the following:
 - a. Schedules and coordination requirements.

- b. Final locations as required by authorities having jurisdiction.

1.4 COORDINATION

- A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Source Limitations: Obtain fire-protection cabinets from single source from single manufacturer.

1.5 SEQUENCING

- A. Apply vinyl lettering on field-painted, fire protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHER

Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.

- 1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge
 - 1. Class: A:B:C type.
 - 2. Size: 10 pound.

2.2 FIRE PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Larsen's Manufacturing Company; Model 2712-R or comparable product by one of the following:
 - a. J. L. Industries, Inc., a division of Activar Construction Products Group.
 - b. Potter Roemer LLC.
- B. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- C. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.

- D. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- E. Finish of Cabinet Exterior Trim and Door: Anodized to standard color.
- F. Finish of Cabinet Interior: White colored enamel.
- G. Product: Basis of Design Model: Larsen's Manufacturing Company: Series 2409, mounting and fire-rated as indicated by wall types.
- H. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
 - 1. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide recessed door pull and friction latch.
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- J. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.
 - a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet door.
 - 2) Application Process: Decals.
 - 3) Lettering Color: Red.
 - 4) Orientation: Horizontal.
- K. Finishes:
 - 1. Manufacturer's standard baked-enamel paint for the following:
 - a. Exterior of cabinet, door, and trim except for those surfaces indicated to receive another finish.
 - b. Interior of cabinet and door.
 - 2. Steel: Baked enamel finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
 - 1. Fire Protection Cabinets: 48 inches maximum to top of fire extinguisher handle; 42 inches maximum to top of fire extinguisher handle if weight is greater than 40 lb.
- B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide semi-recessed fire protection cabinets. .
 - 2. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.
- C. Identification: Apply vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 117000.C EQUIPMENT

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The General Conditions of the Contract for Construction, Supplementary Conditions, Division I Specification sections, and other material bound in this Manual or referred to therein are a part of this Section.

1.02 DESCRIPTION OF WORK

- A. Where equipment is indicated to be furnished and installed by Contractor (C), installation shall be complete including roughing-in all required services, all final connections, and all ancillary supports required for a complete installation.
- B. Where equipment is indicated (E), this equipment is existing to remain.
- C. Where equipment is indicated to be furnished and installed by Owner (O), installation shall be complete including all final connections. Roughing-in shall be done by Contractor as indicated on Mechanical and Electrical Drawings.
- D. Where equipment is indicated to be furnished by Owner and installed by Contractor (OC), Owner will have the equipment delivered to the construction site. Contractor shall receive the equipment, place it in its proper location, and install. Installation shall include roughing-in all required services per equipment manufacturer's data, all final connections and all ancillary supports required for a complete installation.
- E. Where equipment is indicated to be relocated by the owner (OR), this equipment is existing equipment and is presently located in the building. Owner will disconnect the existing equipment, move it to its new location and install. Roughing-in shall be done by the Contractor as indicated on Mechanical and Electrical Drawings.
- F. Where equipment is indicated to be relocated (R), this equipment is existing equipment and is presently located in the building. Contractor shall disconnect the existing equipment, move it to its new location and install. Installation shall include roughing-in all required services, all final connections and all ancillary supports required for a complete installation.
- G. Where equipment is indicated to be furnished and installed by the Equipment Vendor (V), the Contractor shall rough-in all required services per data furnished by Vendor and all ancillary supports required for a complete installation. Final connections will be made by the Vendor.
- H. Where equipment is indicated to be furnished by Vendor and installed by Contractor (VC), Vendor shall have equipment delivered to the construction site. Contractor shall receive the equipment, place it in its proper location, and install. Installations shall include roughing-in all required services (per data furnished by Vendor) and all final connections including all ancillary supports required for a complete installation.

- I. Where equipment is indicated to be vendor relocated (VR), this equipment is equipment presently located on the site. Vendor shall disconnect the existing equipment, move it to its new location and install. The Contractor shall rough-in all required services including all ancillary supports required for a complete installation. Final connections will be made by the Vendor.
- J. Refer to Drawings and Equipment Schedule on Drawing No. A-201 for quantity, layout, location and description of equipment. Where Drawings are noted "Typical," they shall be applicable to all similar rooms on all floors.
- K. Catalog or model numbers referred to in the Schedule are in lieu of complete written descriptions. All equipment shall be as illustrated and described under the respective catalog or model numbers, unless modified by these specifications or on the Drawings.

END OF SECTION

SECTION 122413.C - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Roller shades, manual operation and accessories.
- B. Shade fabric.

1.2 RELATED SECTIONS

- A. Section 06100 - Rough Carpentry: Wood blocking and grounds for mounting roller shades and accessories.
- B. Section 09260 - Gypsum Board Assemblies: Coordination with gypsum board assemblies for installation of shade pockets, closures and related accessories.
- C. Section 09510 - Acoustical Ceilings: Coordination with acoustical ceiling systems for installation of shade pockets, closures and related accessories.

1.3 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM G21 and E 2180 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- B. Cradle to Cradle Products Innovation Institute (C2C):
 - 1. C2C (DIR) - C2C Certified Products Registry.
- C. National Fire Protection Association (NFPA):
 - 1. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
- D. Window Covering Manufacturers Association (WCMA):
 - 1. ANSI/WCMA A100.1-2022- Safety of Window Covering Products; 2022.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: One week prior to commencing work related to this section. Require attendance of all affected installers.
- B. Sequencing:
 - 1. Do not fabricate shades until field dimensions for each opening have been taken with finished conditions in place. "Hold to" dimensions are not acceptable.
 - 2. Do not install shades until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Bid Submittal: Information Required with Submittal of Bid: In order to evaluate proposals for integrated lighting control and window shade systems, the Architect requires the following information be submitted prior to the award of the system.
 - 1. Bid proposal shall be accompanied with a document that notes all deviations from these specifications on a line-by-line basis.
- C. Product Data: Manufacturer's catalog pages and data sheets for products specified including materials, finishes, dimensions, profiles, mountings, and accessories.
 - 1. Preparation instructions and recommendations.
 - 2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes, accessories, and operating instructions.
 - 3. Storage and handling requirements and recommendations.
 - 4. Mounting details and installation methods.
 - 5. Manufacturer's Instructions: Include storage, handling, protection, examination, preparation, and installation.
 - 6. Project Record Documents: Record actual locations of control system components and show interconnecting wiring.
 - 7. Operation and Maintenance Data: Component list with part numbers, and operation and maintenance instructions.
- D. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, and relationship to adjacent work.
 - 1. Prepare shop drawings on AutoCad or MicroStation format using base sheets provided electronically by the Architect.
 - 2. Provide location plan showing all manual shade control locations. Cross-reference furniture plans for optimal positioning of chains.
 - 3. Provide elevation drawings showing shade band layout. Indicate any necessary seam or batten locations, and align with horizontal mullions where possible.
- A. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.
- B. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements.
 - 4. Shadecloth Sample: Mark face of material to indicate interior faces.
 - a. Test reports indicating compliance with specified fabric properties.
 - b. Verification Samples: 6 inches (150 mm) square, representing actual materials, color and pattern.
- C. Maintenance Data: Bill of materials for all components with part numbers. Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.
- D. Warranty: Provide manufacturer's warranty documents as specified in this Section.

1.6 QUALITY ASSURANCE

- A. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- B. Manufacturer Qualifications: Obtain roller shades system through one source from a single manufacturer with a minimum of ten years experience and minimum of five projects of similar scope and size in manufacturing products comparable to those specified in this section.
- C. Installer for Roller Shade System - Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.
 - 1. Requirements for Roller Shade Installer/Contractor:
 - a. Roller Shade Hardware, shade fabric and all related controls shall be furnished and installed as a complete assembly.
- D. Product Listing Organization Qualifications: Organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- E. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.
- F. ShadeCloth Anti-Microbial Characteristics: 'No Growth' per ASTM G 21 results for fungi ATCC9642, ATCC9644 and ATCC9645, and E2180.
- G. ShadeCloth Cleanability and Disinfecting: ShadeCloth must meet cleanability and disinfecting requirements via 3rd party testing to comply with BIFMA HCF 8.1-2014 standards using chemical solutions compliant with EPA guidelines for use against COVID-19.
- H. Environmental Certification: Submit written certification from the manufacturer, including third party evaluation, recycling characteristics, and perpetual use certification as specified. Initial submittals, which do not include the Environmental Certification will be rejected. Materials that are simply 'PVC free' without identifying their inputs shall not qualify as meeting the intent of this specification and shall be rejected.
- I. Third Party Evaluation: Provide documentation stating the shade cloth has undergone third party evaluation for all chemical inputs, down to a scale of 100 parts per million, that have been evaluated for human and environmental safety. Identify any and all inputs, which are known to be carcinogenic, mutagenic, teratogenic, reproductively toxic, or endocrine disrupting. Also identify items that are toxic to aquatic systems, contain heavy metals, or organohalogens. The material shall contain no inputs that are known problems to human or environmental health per the above major criteria, except for an input that is required to meet local fire codes.

- J. Recycling Characteristics: Provide documentation that the shade cloth can, and is part of a closed loop of perpetual use and not be required to be down cycled, incinerated or otherwise thrown away. Scrap material can be sent back to the mill for reprocessing and recycling into the same quality yarn and woven into new material, without down cycling. Certify that this process is currently underway and will be utilized for this project.
- K. Perpetual Use Certification: Certify that at the end of the useful life of the shade cloth, that the material can be sent back to the manufacturer for recapture as part of a closed loop of perpetual use and that the material can and will be reconstituted into new yarn, for weaving into new shade cloth. Provide information on each shade band indicating that the shade band can be sent back to the manufacturer for this purpose.

1.7 MOCK-UP

- A. Provide a mock-up of one roller shade assembly for evaluation of mounting, appearance and accessories.
 - 1. Locate mock-up in window designated by Architect.
 - 2. Mockup Size: Full size.
 - 3. Mockup Size (WxH): 3 x 3 feet (0.94 x 0.94 m) minimum.
 - 4. Intent of mock-up is to demonstrate quality of workmanship and visual appearance.
 - 5. If mock-up is not acceptable, rebuild mock-up until satisfactory results are achieved.
 - 6. Do not proceed with remaining work until, mock-up is accepted by Architect.
 - 7. Retain mock-up during construction as a standard for comparison with completed work.
 - 8. Do not alter or remove mock-up until work is completed or removal is authorized.
 - 9. Full-sized mock-up may become part of the final installation.
 - 10. Full-sized mock-up will become the property of the Owner to be used for spare parts.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in Window Treatment Schedule.
- B. Store and handle products per manufacturer's recommendations.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.10 WARRANTY

- A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating, transferrable warranty for interior shading.
 - 1. Shade Hardware – 10 years unless otherwise indicated:
 - a. Mecho/5 and Mecho/5x with ThermoVeil, EuroTwill, Soho, Equinox, Midnite, Chelsea, or Classic Blackout shade fabric: 25-years.
 - b. Mecho/7 including bead chain with ThermoVeil, EuroTwill, Soho, Equinox, Midnite, Chelsea, or Classic Blackout shade fabric: 25-years.
 - 2. Standard Shadecloth: Manufacturer's standard 25-year warranty.
 - 3. EcoVeil and EcoVeil Sheer Shadecloth: Manufacturer's standard 10-year warranty.
 - 4. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas, which are deemed owners responsibility.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer for Window Shade Control System as basis of design, performance and warranty: Mecho Shades
- B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 APPLICATIONS/SCOPE

- A. Roller Shade Schedule:
 - 1. Shade Type WS1: Manual operating, chain drive, sunscreen single roller shades and related mounting systems and accessories as indicated on drawings.
 - 2. CPSC Compliance: All manually operated window coverings with accessible cords, chains, continuous loop cords, etc. shall meet all current Federally mandated CPSC (Consumer Products Safety Commission) safety standards at time of manufacturing. Depending on the product type, additional hardware components may be required and added to meet new regulatory compliant anti-ligature requirements.
 - 3. WCMA Compliance: Chain tensioning device complying with ANSI/WCMA A100.1-2022 manufacuted on every manual roller shade.

2.3 ROLLER SHADES, MANUAL OPERATION AND ACCESSORIES

- A. Shade System; General:
 - 1. Components capable of being removed or adjusted without removing mounted shade brackets, or cassette support channel.
 - 2. Smoothly operation raising or lowering shades.
 - 3. Cradle-to-Cradle certified and listed in C2C (DIR).
 - 4. Environmental Product Declaration (EPD): Published disclosure of product's environmental impacts based on a full Life Cycle Assessment (LCA).

Manufacturer must have EPD certification by independent 3rd party evaluation service.

- B. Basis of Design: Mecho/5 System as manufactured by Mecho.
1. Description: Manually operated fabric window shades.
 - a. Shade Type: Single Roller.
 - b. Universal drive capability to offset drive chain for reverse or regular roll shades.
 - c. Drop Position: Regular roll.
 - d. Mounting: Surface-mounted.
 - e. Size: Full length of interior windows as indicated on drawings.
 - f. Fabric: As specified. Refer to Interior Finish Schedule.
 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - a. Material: Steel, 1/8 inch (3 mm) thick. Styrene based plastics, and /or polyester, or reinforced polyester shall not be accepted.
 - b. Single Shade Operation Width: Up to 180 inches (4572 mm) dependent on fabric.
 3. Roller Tubes:
 - a. Material: Extruded aluminum.
 - b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
 - d. Roller tubes to be capable of being removed and reinstalled without affecting roller shade limit adjustments.
 4. Hembars: Designed to maintain bottom of shade straight and flat.
 - a. Style: Full wrap fabric-covered bottom bar, flat profile with heat sealed closed ends.
 - b. Style: Exposed aluminum bottom bar with matching finials.
 - 1) Profile: Rectangular.
 - 2) Color: To be selected by Architect from manufacturer's standard color selection.
 5. Clutch Operator: Manufacturer's standard material and design integrated with bracket/brake assembly.
 - a. Heavy-duty, 1/8" steel mounting bracket and integrated steel brake, clutch and sprocket assembly rigidly affix the shade support and user control to the building structure fully independent of the roller tube components.
 - b. Permanently lubricated maintenance-free brake assembly employs an oil-impregnated steel hub with wrapped spring clutch.
 - c. Brake must withstand minimum pull force of 50 pounds (22.7 kg) in the stopped position.

- d. Direct drive clutch requires no interstitial gear stages or plastic parts between the building structure and clutch ensuring reliable operation across the full range of shade sizes.
 - e. Urethane dampened clutch protects bead chain and clutch from failure due to high shock loads during shade operation minimizing down time.
 - f. Maximum shade hanging weight of 50 pounds (22.7 kg).
 - g. Clutch shall be upgradable to motorized drive on compatible tubes without requiring change in mounting attachment method/location, roller tube or fabric band.
 - h. Motorized drive options available require no additional wiring to be added for power or communication capability for switch or automated operation.
6. Drive Chain: Continuous loop T304 stainless steel beaded ball chain, 100 pound (45 kg) minimum breaking strength warranted from breaking for the life of the shade system hardware under prescribed operation. Provide upper and lower limit stops.
- a. Chain Tensioner: Chain tensioning device complying with ANSI/WCMA A100.1-2022.
 - b. Limit stops: Bead stops affixed to the chain maintain consistent shadeband alignment at the top and bottom of shade travel across multiple shades, and help prevent shade damage resulting from unmanaged user control.
7. Accessories:
- a. Fascia: Removable extruded aluminum fascia, size as required to conceal shade mounting, attachable to brackets without exposed fasteners.
 - 1) Finish: Fabric wrapped to match shade.
 - 2) Can be installed across two or more shade bands in one piece.
 - 3) Single Fascia: Accommodate regular roll shades.
 - 4) Profile: Square.
 - 5) Configuration: Continuous, fascia extends past continuous bracket.
 - 6) Configuration: Captured and continuous, as indicated on drawings.

2.4 ROLLER SHADE FABRICATION

- A. Field measure finished openings prior to ordering or fabrication.
- B. Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.
 - 1. Vertical Dimensions: Fill Opening from Head to Sill: 1/2 inch (13 mm) space between bottom bar and window sill.
 - 2. Horizontal Dimensions: Inside Mounting.
 - a. Fill openings from jamb to jamb. No light gap.
 - 3. Horizontal Dimensions: Outside mounting.
 - a. Cover window frames, trim, and casings completely.

2.5 SHADE FABRIC

- A. Basis of Design: Shade fabric as manufactured by MechoShade Systems LLC.
 - 1. Solar Shadecloths: As specified. Refer to Interior Finish Material Legend.
 - 2. Performance Requirements:
 - a. Flammability per NFPA 701: Pass. Large or small scale test.
 - b. Fungal Resistance: No growth when tested per ASTM G21.
 - c. Cleanability and Disinfecting: ShadeCloth must meet cleanability and disinfecting requirements via 3rd party testing to comply with BIFMA HCF 8.1-2014 standards using chemical solutions compliant with EPA guidelines for use against COVID-19.
 - 3. Fabrication:
 - a. Fabric Orientation: Railroaded, fabric is turned 90 degrees off the roll.
 - b. Battens: Manufacturer's standard material, full width of shade, and enclosed in welded shade fabric pocket; locate as indicated on drawings.
 - c. Seams for Railroaded Fabric: Manufacturer's standard seam; locate as indicated on drawings.
 - d. Welded Zipper Edge: Full height on both sides of fabric ensuring smooth operation within ShadeLoc channels.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Start of installation shall be considered acceptance of substrates.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
- C. Coordinate with window installation and placement of concealed blocking to support shades.

3.3 INSTALLATION

- A. Contractor Furnish and Install Responsibilities:
 - 1. Window Covering Contractor (WC) shall provide an on site, Project Manager, and shall be present for all related jobsite scheduling meetings.
 - 2. WC shall supervise the roller shade installation, and setting of intermediate stops of all shades.

3. WC shall be responsible for field inspection on an area-by- area and floor-by-floor basis during construction to confirm proper mounting conditions per approved shop drawings.
4. Verification of Conditions: examine the areas to receive the work and the conditions under which the work would be performed and notify General Contractor and Owner of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected. Commencement of installation shall constitute acceptance of substrate conditions by the installer.
5. WC shall provide accurate to 0.0625" inch (1.5875mm); field measurements for custom shade fabrication on the Roller Shades manufacturers input forms.
6. WC Installer shall install roller shades level, plumb, square, and true according to manufacturer's written instructions, and as specified here in. Blocking for roller shades installed under the contract of the interior General Contractor shall be installed plumb, level, and fitted to window mullion as per interior architect's design documents and in accordance with industry standard tolerances. The horizontal surface of the shade pocket shall not be out-of-level more than 0.625" (15.875mm) over 20 linear feet (6.096 meters)
7. Shades shall be located so the shade band is not closer than 2 inches (50 mm) to the interior face of the glass. Allow proper clearances for window operation hardware.
8. Adjust, align and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
9. Installer shall set Upper and Lower limits of all manual shade bands, and assure alignment in accordance with the above requirements.
10. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
11. WC shall train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.
 - a. Use operation and maintenance manual as a reference, supplemented with additional training materials as required.

3.4 PROTECTION AND CLEANING

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.
 1. Clean soiled shades and exposed components as recommended by manufacturer.
 2. Replace shades that cannot be cleaned to "like new" condition.

END OF SECTION

SECTION 123661.16.C - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid surface material countertops.
2. Solid surface material backsplashes.
3. Solid surface material end splashes.
4. Solid surface material apron fronts.

B. Related Requirements:

1. Section 064116 "Plastic Laminate Clad Architectural Cabinets"
2. Section 224100 "Residential Plumbing Fixtures" for sinks and plumbing fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For countertop materials

B. Samples: For each exposed product and for each color and texture specified.

1.3 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.4 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ISFA 2-01.

1. Colors and Patterns: Refer to Interior Finish Schedule.

B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Premium.
- B. Configuration as detailed in drawings.

Countertops: 1/2-inch- thick, solid surface material with front edge built up with same material.
- C. Backsplashes: 1/2-inch thick, solid surface material.
- D. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
- E. Joints: Fabricate countertops without joints.
- F. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting **3/16 inch** into fixture opening.
 - b. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
 - c. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.

- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Apply sealant to gaps at walls; comply with Section 07 9200 "Joint Sealants."

END OF SECTION

SECTION 134900.C - RADIATION PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Radiation protection products including the following:
 - 1. Lead-laminated gypsum board.
 - 2. Radiation shielding leaded glass.
 - 3. Lead-lined hollow metal view window frames.

1.2 RELATED SECTIONS:

- A. Section 08 11 13 - Hollow Metal Doors and Frames.
- B. Section 09 21 16 - Gypsum Board Shaft Wall Assemblies.
- C. Section 09 90 00 - Painting and Coating.
- D. Attached Shielding Protection Report

1.3 REFERENCES

- A. American Wood Products Association (AWPA): AWPA C27 - Fire Retardant Treatment by Pressure Processes.
- B. ASTM International (ASTM):
 - 1. ASTM A 36 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A 366 - Standard Specification for Commercial Steel (CS) Sheet, Carbon (0.15 Maximum Percent) Cold-Rolled.
 - 3. ASTM A 500 - Standard Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 4. ASTM A 526 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
 - 5. ASTM B 749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
 - 6. ASTM C 1396 - Standard Specification for Gypsum Board.
- C. Federal Specifications:
 - 1. QQL-171 Grade C.
 - 2. QQL-201 F Grade C.
- D. Hollow Metal Manufacturers Association (HMMA):
 - 1. HMMA 840 - Installation and Storage of Hollow Metal Doors.
 - 2. HMMA 861 - Commercial Hollow Metal Doors and Frames.
- E. National Electric Manufacturers Association (NEMA): LD 3 - High Pressure Decorative Laminates.
- F. National Council on Radiation Protection (NCRP): Reports No. 33, No. 35 and No.

49.

- G. Steel Door Institute (SDI): SDI-100 - Recommended Specifications for Standard Steel Doors and Frames.

1.4 DEFINITIONS

- A. Lead Equivalence: Thickness of lead that provides same attenuation (reduction of radiation passing through) as material in question under specified conditions. Lead equivalence specified for materials used in diagnostic X-Ray rooms is measured at 150 kV unless indicated otherwise.

1.5 DESCRIPTION OF WORK

- A. Furnish and install all protection shown on the Drawings and specified herein. An unbroken barrier of sheet lead shall be provided on room side of all partitions (including openings therein) and recesses enclosing rooms noted or scheduled to be protected, continuously from top of concrete floor slab to a height of 7'-0" above the floor or to ceiling as indicated.
- B. Fabrication and erection shall be done by a designated specialty contractor specializing in this type of work, and only by a contractor approved by Architect. Workmanship shall be first class in every respect, and subject to Architect's directions and approval.
- C. Contractor for radiation protection shall furnish and install, or have installed under his direct and constant supervision, all materials and equipment, including attachment devices, necessary for the completion of all radiation protection work required for the full and complete radiation protection of the rooms indicated, on the Drawings, and herein specified
- D. Where existing radiation protection work is cut, damaged, or otherwise compromised, repair existing protection as required to provide the radiation protection indicated on the physicist's Shielding Calculations and on the contract documents.
- E. All lead shall be provided and installed to meet the requirements of the Shielding Calculations prepared by the Hospital's Physicist, attached.

1.6 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and all directions equivalent to materials specified in thicknesses and locations indicated.
 - 2. Lead-Lined Assemblies: Provide lead thickness in doors, door frames, window frames, and other items located in lead-lined assemblies, not less than that indicated for assemblies in which they are installed unless indicated otherwise.

3. Lead Glazing: Provide lead equivalence not less than that indicated for assembly in which glazing is installed unless indicated otherwise.

1.7 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Shop Drawings:
 1. Indicate dimensions, description of materials and finishes and general construction.
 2. Indicate layout of radiation-protected areas.
 3. Indicate lead thickness or lead equivalencies of components.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.8 QUALITY ASSURANCE

- A. Qualifications: Firm with minimum of 5 years successful experience manufacturing radiation protection products similar to those specified for this Project.
- B. Radiation Protection Work: Comply with National Council of Radiation Protection (NCRP) Report No. 049 - Structural Shielding Design and Evaluation for Medical Use of X-Rays and Gamma Rays of Energies up to 10 MeV.
 1. Comply with requirements of local regulatory agencies where local standards and criteria exceed requirements of NCRP Report No. 049.
- C. Single Source Responsibility: Obtain radiation protection materials and accessories produced as standard products from single manufacturer regularly engaged in production of X-Ray shielding materials, equipment, and accessories.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's instruction for receiving, handling, storing, and protecting materials.

- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Store materials in original packaging, protected from exposure to harmful environmental conditions, including static electricity, and at temperature and humidity conditions recommended by manufacturer.
- D. Exercise care to prevent edge damaged materials.

1.10 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.11 WARRANTY

- A. Provide manufacturer's

standard limited warranty. PART 2

PRODUCTS

2.1 LEAD

- A. Lead shall be 99.9% pure virgin lead sheet conforming to Federal Specifications QQ-L-201, Grade C, of thickness indicated

2.2 LEAD LAMINATED GYPSUM BOARD (GWB)

- A. Nelco or USG - 5/8" thick gypsum drywall panels (GWB) specified in Section 09250, factory- laminated with permanent adhesive to unpierced sheet lead thickness and height as indicated.
- B. Apply 2" wide strip of sheet lead (of same thickness) to the furring or studs prior to installation of drywall panels to provide a minimum 1" overlap at joints. Install shims of same thickness as lead at intermediate studs or furring and above 7'-0" (where lead is not required) to provide a smooth flat surface.
- C. Attach lead-laminated drywall panels to metal studs or furring specified in Section 09250 in accordance with USG specifications, modified as necessary to provide a continuous unbroken lead barrier. Pre-drill as required to prevent distortion of the wallboard. Apply lead discs as required to maintain integrity of lead barrier.

2.3 LEAD GLASS

- A. Clear leaded glass containing 48 percent lead oxide (by weight) and 15 percent barium. Thickness as required to provide radiation protection equivalent to that provided by sheet lead in partition in which lead glass is installed. Equivalencies based on 150 kV unless indicated otherwise.
 - 1. Equivalency: 0.4 mm.

2.4 LEAD-LINED HOLLOW METAL VIEW WINDOW FRAMES

- A. Hollow metal frames are specified in Section 081113.
- B. Insulate frames with sheet lead for continuation of room barrier, giving special attention to providing overlap of the shielding in door frames and its continuity with shielding of door and partition.
- C. Design window frames to accept any thickness of radiation shielding leaded glass, radiation shielding X-Ray safety glass, or radiation shielding leaded acrylic.
- D. Provide radiation protection equivalent to that provided by sheet lead in partition in which view window is installed.
- E. Provide 1/2 inch (13 mm) removable stops.

2.5 ACCESSORIES

- A. Lead Strips: 2 inches (51 mm) wide, unless indicated otherwise, by same thickness as sheet lead laminated on gypsum board.
- B. Lead Discs: 3/8 inch (9.5 mm) diameter lead discs for use with screw heads.
- C. Adhesive: Acceptable to radiation protection product manufacturer and capable of adhering lead sheets where required.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Verify that steel framing is not less than 20 gage (0.9 mm) with studs spaced not more than 16 inches (406 mm) on center, unless noted otherwise.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LEAD-LAMINATED GYPSUM BOARD

- A. Comply with manufacturer's recommendations.
- B. Adhere lead strips on face of studs at joints in lead-laminated gypsum board, including inside and outside corners. Use 2 inches (50 mm) wide strips by same thickness as sheet lead laminated on gypsum board.
- C. Shim studs and other framing members as necessary to provide flat, flush finished surfaces.
- D. Install lead-laminated gypsum board on framing with screws spaced not more than 8 inches (203 mm) on center along edges of board and 12

inches (305 mm) on center in field of board.

- E. Adhere lead discs to fastener heads. In each case, use method that provides continuous radiation shielding.
- F. Where lead-laminated gypsum board is final substrate, apply joint treatment on fasteners and joints per Section 09 21 16.
- G. Where second layer of gypsum board occurs over lead-laminated gypsum board, comply with Section 09 21 16 - Gypsum Board Shaft Wall Assemblies.

3.3 INSTALLATION OF WINDOW FRAMES

- A. Set unleaded side of frame plumb and square in wall opening on control room side of wall with shims.
- B. Set leaded side of frame plumb and square in wall opening on X-Ray side of wall.
- C. Compress sides together against faces of wall.
- D. Install setting blocks, shims, and glazing tape in glazing channel to prevent galls from touching steel frame.
- E. Install radiation resistant glazing in telescopic frame.
- F. Place steel stops in position and mark location of stop and frame retaining holes on steel frame.
- G. Remove glazing and drill holes in steel frame.
- H. Place glazing and stops and hand drive setting screws.

3.4 INSTALLATION OF PENETRATING ITEMS

- A. At penetrations of lead linings; provide lead shields to maintain continuity of protection.
- B. Provide lead linings, sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.
- C. Cut wall penetration covers from lead sheet of equal or greater thickness than backing on adjacent wall panels. Cut wall penetration covers to size required to cover wall penetrations with laps 1 inch (25 mm) minimum wide as indicated on penetration detail drawings.
- D. Adhesive-apply lead sheet penetration covers on penetrating boxes and raceways and return penetration covers to backside of lead-backed wall panels with 1 inch (25 mm) minimum laps.
 - 1. Do not use penetrating fasteners unless indicated otherwise.
- E. Install outlet boxes and conduit between studs using steel telescoping mounting brackets. Cover or line with lead sheet lapped over adjacent lead lining at least 1 inch (25 mm). Wrap conduit with lead sheet for 10

inches (250 mm) in from box.

3.5 INSTALLATION OF WALL PENETRATION COVERS

- A. Duct Penetrations With 8 PSF or Less Lead Sheet:
 - 1. Wrap ducts with wall penetration covers, lapping lead joints 1 inch (25 mm) minimum.
 - 2. Secure lead sheet in place with 1 inch (25 mm) minimum width steel bands spaced not more than 12 inches (305 mm) on center.
 - 3. Do not cut into lead sheet with tightening steel bands.
- B. Duct Penetrations with Greater than 8 psf Lead Sheet and Where Duct Shielding Exceeds 24 Inches (610 mm) in Width:
 - 1. Laminate wall penetration covers to plywood or other similar structural panels conforming to shape of duct, lapping lead joints 1 inch (25 mm) minimum.
 - 2. Secure lead laminated panels to ducts with mechanical fasteners located at duct seams and corners.
 - 3. Where necessary to prevent lead laminated panels from overloading duct supports, independently suspend panels from hangers secured to overhead building structure.
 - 4. Cover fastener heads with lead sheet matching thickness of adjacent lead.
- C. Piping: Unless indicated otherwise, wrap piping with lead sheet for 10 inches (250 mm) from point of penetration.

3.6 ACCESSORY INSTALLATION

- A. Comply with manufacturer's recommendations.
- B. Wherever lead protection is penetrated, cut, or punctured, assure continuity of shielding by use of sheet lead, lead plugs or other approved method.
- C. Install sheet lead lining within steel door frames to provide radiation protection to levels indicated or levels required to match adjacent wall protection.
- D. Wrap electrical outlet boxes, view window frames, and other penetrations through lead barrier material with sheet lead to provide radiation protection to levels indicated or levels required to match adjacent wall protection.

3.7 FIELD QUALITY CONTROL

- A. Field Inspection: Owner will engage qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Correct deficiencies in, or remove and replace, radiation protection that inspection reports indicate does not comply with specified requirements.
- C. Testing: At completion of the installation of all radiation protection work,

Owner shall engage an approved Radiological Physicist to conduct radiation surveys and test all radiation protection for conformance with contract documents.

1. Should the radiation survey and test results indicate corrective work is required, contractor shall repair or replace defective work including other work affected thereby and conduct additional testing to the satisfaction of the Radiological Physicist at no additional expense to the Owner
2. Radiological Physicist shall, at completion, certify in writing that all radiation protection work has been furnished, installed and tested in accordance with the contract documents

- D. Correct deficiencies in, or remove and replace, radiation protection that testing indicates does not comply with specified requirements, including finishes and other Work covering defective Work.

3.8 CLEANING

- A. Remove excess materials from site and leave Work areas broomclean.
- B. Leave exposed surfaces ready for site finishing.

3.9 PROTECTION

- A. Lock radiation-protected rooms once doors hardware is installed. Limit access to only those persons performing Work in radiation-protected rooms or as directed by Owner.
- B. Tape temporary paper signs on radiation-resistant walls with the following text:
 1. "Do not mount equipment on this wall without covering penetrating fasteners with lead sheet of thickness required by contract documents".

END OF SECTION

SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section includes:

1. Motors.
2. Sleeves without waterstop.
3. Sleeves with waterstop.
4. Stack-sleeve fittings.
5. Sleeve-seal systems.
6. Grout.
7. Silicone sealants.
8. Escutcheons.

1.2 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

1. For each type of product, excluding motors which are included in Part 1 of the fire-suppression equipment Sections.
 - a. Include construction details, material descriptions, and dimensions of components.
 - b. Include operating characteristics and furnished accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
1. Motor controllers.
 2. Torque, speed, and horsepower requirements of the load.
 3. Ratings and characteristics of supply circuit and required control sequence.
 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. (1000 m) above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
 - a. For motors with 2:1 speed ratio, consequent pole, single winding.
 - b. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Multispeed Motors, Multiple Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Code Letter Designation:
 - a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
 - b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor.
 - b. Split phase.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run.
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts 120 V or 240 V single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. digital speed controller/LED display.
4. Building Automation System Interface: Via **[AC voltage signal] [DC voltage signal] [or] [Digital Serial Interface (DSI)]**.

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge (0.6 mm) minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.

6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.
- B. Sleeves with Waterstop:
1. Description: Manufactured [**PVC/HDPE**] [**steel**] [**stainless steel**] [**galvanized steel**], sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- C. Stack-Sleeve Fittings:
1. Description: Manufactured, [**Dura-coated or Duco-coated**] [**galvanized**] cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with setscrews.
- D. Sleeve-Seal Systems:.
1. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - a. Hydrostatic Seal: 20 psig (137 kPa) minimum.
 - b. Sealing Elements: [**EPDM-rubber**] [**High-temperature-silicone**] [**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - c. Pressure Plates: [**Carbon steel**] [**Composite plastic**] [**Stainless steel**] [**Stainless steel, Type 316**].
 - d. Connecting Bolts and Nuts: [**Carbon steel, with ASTM B633 coating**] [**Stainless steel**] [**Stainless steel, Type 316,**] of length required to secure pressure plates to sealing elements.
- E. Grout:
1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
 2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 3. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
 4. Packaging: Premixed and factory packaged.
- F. Silicone Sealants:
1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

2. Silicone Sealant, S, P, T, NT: Single-component, [25] [100/50], pourable, [plus 25 percent and minus 25 percent] [plus 100 percent and minus 50 percent] movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.
 - a. Standard: ASTM C920, Type S, Grade P, [Class 25] [Class 100/50], Uses T and NT.
3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.3 ESCUTCHEONS

A. Escutcheon Types:

1. One-Piece, Steel Type: With [polished, chrome-plated] [polished brass] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [polished, chrome-plated] [polished brass] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [steel] [brass] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [concealed] [and] [exposed-rivet] hinge; and spring-clip fasteners.

B. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

- A. Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.2 INSTALLATION OF SLEEVES, GENERAL

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [1-inch (25-mm)] [2-inch (50-mm)] <Insert dimension> annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches (50 mm)**] <Insert dimension> above finished floor level.
3. Using [**grout**] [**or**] [**silicone sealant**], seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire-resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

- A. Install sleeve with waterstop as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width centered in concrete slab or wall.
- C. Secure nailing flanges to wooden concrete forms.
- D. Using [**grout**] [**or**] [**silicone sealant**], seal space around outside of sleeves.

3.4 INSTALLATION OF STACK-SLEEVE FITTINGS

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 3 inches (75 mm) above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.6 INSTALLATION OF ESCUTCHEONS

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.7 FIELD QUALITY CONTROL

- A. Sleeves and Sleeve Seals:
 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
 2. Prepare test and inspection reports.
- B. Escutcheons:
 1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.8 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls above and below Grade:

- a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for [**1-inch (25-mm)**] **<Insert dimension>** annular clear space between piping and sleeve for installing sleeve-seal system.
2. Concrete Slabs-on-Grade:
 - a. Sleeves with waterstops.
 - 1) Select sleeve size to allow for [**1-inch (25-mm)**] **<Insert dimension>** annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs above Grade:
 - a. Sleeves with waterstops.
4. Interior Walls and Partitions:
 - a. Sleeves without waterstops.

3.9 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece[, **steel**] [, **cast brass**][**or split plate steel**] with polished, chrome-plated finish.
3. Insulated Piping:
 - a. One piece, steel with [**polished, chrome-plated**] [**polished brass**] finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with [**polished, chrome-plated**] [**polished brass**] finish.
 - d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**] [**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.
4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - a. One piece, steel with [**polished, chrome-plated**] [**polished brass**] finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with [**polished, chrome-plated**] [**polished brass**] finish.
 - d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**] [**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.
5. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, steel with [**polished, chrome-plated**] [**polished brass**] finish.
 - b. One piece, stainless steel with polished stainless steel finish.

- c. One piece, cast brass with **[polished, chrome-plated] [polished brass]** finish.
 - d. One piece, stamped steel **[or split plate, stamped steel with concealed hinge] [or split plate, stamped steel with exposed-rivet hinge]** with polished, chrome-plated finish.
- 6. Bare Piping in Unfinished Service Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with **[polished, chrome-plated] [rough-brass]** finish.
 - c. One piece, stamped steel **[or split plate, stamped steel with concealed hinge] [or split plate, stamped steel with exposed-rivet hinge]** with polished, chrome-plated finish.
- 7. Bare Piping in Equipment Rooms:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with **[polished, chrome-plated] [rough-brass]** finish.
 - c. One piece, stamped steel **[or split plate, stamped steel with concealed hinge] [or split plate, stamped steel with exposed-rivet hinge]** with polished, chrome-plated finish.
- B. Escutcheons for Existing Piping to Remain:
 - 1. Chrome-Plated Piping: Split plate, stamped steel with **[concealed] [or] [exposed-rivet]** hinge with polished, chrome-plated finish.
 - 2. Insulated Piping: Split plate, stamped steel with **[concealed] [or] [exposed-rivet]** hinge with polished, chrome-plated finish.
 - 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with **[concealed] [or] [exposed-rivet]** hinge with polished, chrome-plated finish.
 - 4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with **[concealed] [or] [exposed-rivet]** hinge with polished, chrome-plated finish.
 - 5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with **[concealed] [or] [exposed-rivet]** hinge with polished, chrome-plated finish.
 - 6. Bare Piping in Equipment Rooms: Split plate, stamped steel with **[concealed] [or] [exposed-rivet]** hinge with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping and Relocated Existing Piping: One piece, floor plate.
 - 2. Existing Piping: Split floor plate.

END OF SECTION 210500

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Silicone sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
- E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

- 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Description:

- 1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 2. Designed to form a hydrostatic seal of 20 psig (137 kPa) minimum.
 - 3. Sealing Elements: Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - 4. Pressure Plates: Stainless steel.
 - 5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- B. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - 3. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Use silicone sealant to seal around the outside of stack-sleeve fittings.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.

- D. Use grout to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves.
 - b. Piping NPS 6 (DN 150) and Larger: Cast-iron pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 (DN 150) and Larger: Cast-iron pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 (DN 150) and Larger: Cast-iron pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6 (DN 150): Cast-iron pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for annular clear space between piping and sleeve for installing sleeve-seal system to meet firestopping system requirements.
 - b. Piping NPS 6 (DN 150) and Larger: Cast-iron pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for annular clear space between piping and sleeve for installing sleeve-seal system to meet firestopping system requirements.
5. Interior Partitions:
 - a. Provide sleeves where required for firestopping system.

END OF SECTION 210517

SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports for fire-suppression piping - metal.
2. Pipe hangers for fire-suppression piping - metal, trapeze type.
3. Thermal hanger-shield inserts.
4. Fastener systems.
5. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. [Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment"] [Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment"] for vibration isolation devices[and seismic restraints].

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:[**Signed and sealed by a qualified professional engineer.**] Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for fire-suppression piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with [ASCE/SEI 7] **<Insert requirement>**.
 - 1. Design supports for multiple pipes, including pipe stands capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment[**and obtain approval from authorities having jurisdiction**].
- C. NFPA Compliance: Comply with [NFPA 13] [NFPA 13R] **<Insert standard>**.
- D. UL Compliance: Comply with UL 203.

2.2 PIPE HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION PIPING - METAL

- A. Pipe Hangers and Supports for Fire-Suppression Piping - Carbon Steel:
 - 1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM Global approved for fire-suppression piping support.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**carbon steel**] [**stainless steel**] **<Insert material>**.
- B. Pipe/Tube Hangers and Supports for Fire-Suppression Piping - Copper:
 - 1. Description: Copper-coated-steel, factory-fabricated components, NFPA approved, UL listed, or FM Global approved for fire-suppression piping support.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**copper-coated steel**] [**stainless steel**] **<Insert material>**.

2.3 PIPE HANGERS FOR FIRE-SUPPRESSION PIPING - METAL, TRAPEZE TYPE

- A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM Global-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL HANGER-SHIELD INSERTS

- A. Insulation-Insert Material: **[Water-repellent-treated, ASTM C533, Type I calcium silicate with 100 psi (688 kPa)] [ASTM C552, Type II cellular glass with 100 psi (688 kPa)] [or] [ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi (862 kPa)]** minimum compressive strength.
- B. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield are to cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Fastener System - NFPA/UL/FM Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM Global-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Fastener System - NFPA/UL/FM Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM Global-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Indoor Applications: **[Zinc coated] [or] [Stainless]**.
 - 2. Outdoor Applications: Stainless steel.

2.6 EQUIPMENT SUPPORTS

- A. Description: NFPA-approved, UL-listed, or FM Global-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.7 MATERIALS

- A. Aluminum: ASTM B221 (ASTM B221M).
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry static loads within specified loading limits. Minimum static design load used for strength determination is to comply with NFPA 13 requirements, minimum **[5 times]** <Insert multiplication factor> the water-filled weight of piping and supported components plus **[250 lb (114 kg)]** <Insert value>.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- B. Install lateral bracing with pipe hangers and supports to prevent swaying.
- C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, **[NPS 2-1/2 (DN 65)]** <Insert pipe size> and larger[**and at changes in direction of piping**]. Coordinate location of concrete inserts before concrete is placed.
- D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- E. Pipe Slopes: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- F. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- G. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.
- H. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- I. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners in accordance with powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions. Install in accordance with approvals and listings.
- J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- K. Equipment Support Installation:
1. Fabricate from welded-structural-steel shapes.
 2. Grouting: Place grout under supports for floor-mounted equipment and make bearing surface smooth.
 3. Provide lateral bracing, to prevent swaying.
- L. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. MSS SP-58, Type 39 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

- a. MSS SP-58, Type 40 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for **[trapeze pipe hangers]** **[and]** **[equipment supports]**.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to [1-1/2 inches (40 mm)] <Insert dimension>.

3.6 PAINTING

- A. Touchup:
 - 1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
 - 2. Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in [Section 099113 "Exterior Painting."] [Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel [pipe hangers and supports] [and] [metal trapeze pipe hangers] and attachments for general service applications.
- F. Use [stainless steel] <Insert material> pipe hangers and [stainless steel] [or] [corrosion-resistant] attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and [copper] [or] [stainless steel] attachments for copper piping and tubing.

- H. Use thermal hanger-shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
 - 3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - 4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
 - 5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Comply with NFPA requirements.
- L. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. C-Clamps (MSS Type 23): For structural shapes.
 - 3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- M. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Use [**powder-actuated fasteners**] [**or**] [**mechanical-expansion anchors**] instead of building attachments where required in concrete construction.

END OF SECTION 210529

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape
4. Pipe labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve-numbering scheme.
- E. Valve Schedules: Provide for fire-suppression piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: [**Brass, 0.032 inch (0.8 mm)**] [**stainless steel, 0.025 inch (0.64 mm)**] [**aluminum, 0.032 inch (0.8 mm)**] [**anodized aluminum, 0.032 inch (0.8 mm)**] thick, with predrilled or stamped holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm).

- mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 5. Fasteners: Stainless steel rivets or self-tapping screws.
 - 6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
- 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **[1/16 inch (1.6 mm)] [1/8 inch (3.2 mm)]** **<Insert dimension>** thick, with predrilled holes for attachment hardware.
 - 3. Letter and Background Color: As indicated for specific application under Part 3.
 - 4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **[1/16 inch (1.6 mm)] [1/8 inch (3.2 mm)]** **<Insert dimension>** thick, with predrilled holes for attachment hardware.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- E. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Fasteners: Stainless steel rivets or self-tapping screws.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E[, **and other applicable codes and standards**].
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 WARNING TAPE

- A. Material: Vinyl.
- B. Minimum Thickness: 0.005 inch (0.12 mm).
- C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- E. Maximum Temperature: 160 deg F (70 deg C).
- F. Minimum Width: [**2 inches (50 mm)**] [**4 inches (100 mm)**].

2.4 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- B. Letter and Background Color: As indicated for specific application under Part 3.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to [**partially cover**] [**cover full**] circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:
 - 1. Pipe size.
 - 2. Flow-Direction Arrows: Include flow-direction arrows on[**main**] distribution piping. Arrows may be either integral with label or applied separately.
 - 3. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**] [**At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances**].

2.5 STENCILS

A. Stencils for Piping:

1. Lettering Size: **[Size letters in accordance with ASME A13.1 for piping] [At least 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances].**
2. Stencil Material: Aluminum, brass, or fiberboard.
3. Stencil Paint: Exterior, gloss, **[alkyd enamel] [acrylic enamel] <Insert paint type>.** Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, **[alkyd enamel] [acrylic enamel] <Insert paint type>.** Paint may be in pressurized spray-can form.
5. Letter and Background Color: As indicated for specific application under Part 3.

2.6 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping-system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: **[Brass, 0.04 inch (1.0 mm)] [stainless steel, 0.024 inch (0.61 mm)] [aluminum, 0.031 inch (0.79 mm)] [or] [anodized aluminum, 0.031 inch (0.79 mm)]** thick, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass **[wire] [link chain] [beaded chain] [or] [S-hook].**

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

A. Description: Preprinted**[or partially preprinted,]** accident-prevention tags, of plasticized card stock**[with matte finish suitable for writing].**

1. Size: **[3 by 5-1/4 inches (75 by 133 mm) minimum] [Approximately 4 by 7 inches (100 by 178 mm)] <Insert dimensions>.**
2. Fasteners: **[Brass grommet and wire] [Reinforced grommet and wire or string].**
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of fire-suppression equipment.
- B. Sign and Label Colors:
 - 1. **[White letters on an ANSI Z535.1 safety-red background]** <Insert colors>.
- C. Locate equipment labels where accessible and visible.
- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E[, **and other applicable codes and standards**].

3.4 INSTALLATION OF WARNING TAPE

- A. Warning Tape Color and Pattern: **[Yellow background with black diagonal stripes]** <Insert color, marking pattern, text>.
- B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. (2 m) of clearance.
- C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

- A. Piping Color Coding: Painting of piping is specified in **[Section 099123 "Interior Painting."]** **[Section 099600 "High-Performance Coatings."]**

- B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- C. Stenciled Pipe-Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, [**with painted, color-coded bands or rectangles**] on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Within 3 ft. (1 m) of each valve and control device.
 - 2. At access doors, manholes, and similar access points that permit a view of concealed piping.
 - 3. Within 3 ft. (1 m) of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of [**25 ft. (8 m)**] <Insert dimension> along each run. Reduce intervals to [**10 ft. (3 m)**] <Insert dimension> in areas of congested piping and equipment.
- E. Flow- Direction Arrows: Provide arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- F. Fire-Suppression Pipe Label Color Schedule:
 - 1. Fire-Suppression Pipe Labels: [**White letters on an ANSI Z535.1 safety-red background**] <Insert colors>.

3.6 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule in the operating and maintenance manual. Include the identification "FSV" on all fire-suppression system valve tags.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.
 - 1. Valve-Tag Size and Shape:
 - a. Fire-Suppression Standpipe: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**], [**round**] [**square**] <Insert shape>.
 - b. Wet-Pipe Sprinkler System: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**], [**round**] [**square**] <Insert shape>.
 - c. Dry-Pipe Sprinkler System: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**], [**round**] [**square**] <Insert shape>.
 - d. Foam-Water System: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**], [**round**] [**square**] <Insert shape>.

- e. Clean-Agent Fire-Extinguishing System: [1-1/2 inches (38 mm)] [2 inches (50 mm)], [round] [square] <Insert shape>.
 - f. Preaction System: [1-1/2 inches (38 mm)] [2 inches (50 mm)], [round] [square] <Insert shape>.
2. Valve-Tag Color: [White letters on an ANSI Z535.1 safety-red background] <Insert colors>.

3.7 INSTALLATION OF WARNING TAGS

- A. Warning Tag Color: [Black letters on an ANSI Z535.1 safety-yellow background] <Insert color>.
- B. Attach warning tags, with proper message, to equipment and other items where [indicated on Drawings] [scheduled].

END OF SECTION 210553

SECTION 211000 - WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-suppression piping, fittings, and appurtenances.
2. Fire department connections.
3. Hose connections and hose stations.
4. System control valves.
5. Dry-sprinkler system nitrogen generator with purge/vent.
6. Preaction sprinkler system nitrogen generator with purge/vent.
7. Fire-suppression piping specialties.
8. Cover systems for sprinkler piping.
9. Sprinklers.
10. Alarm devices.
11. Manual control stations.
12. Control panels.
13. Pressure gauges.

B. Related Requirements:

1. Section 331415 "Site Water Distribution Piping" for site fire-suppression water-service and backflow prevention devices.

1.2 DEFINITIONS

- A. Standard-Pressure Fire-Suppression System Piping: Piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.
- B. High-Pressure Fire-Suppression System Piping: Piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than **[250 psig (1725 kPa)] [300 psig (2070 kPa)]**.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles.
 - b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

C. Shop Drawings:

1. Prepare in accordance with [NFPA 13] [and] [NFPA 14] section "Working Plans."
 - a. Include plans, elevations, and sections of the system piping and details.
 - b. Include detailed riser diagram and schematic diagram showing system supply, supply connection, devices, valves, pipe and fittings, as well as the delineation of the standard-pressure and high-pressure portions of the fire-suppression system.
 - c. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Prepare computer-generated hydraulic calculations in accordance with the following:
 - a. Minimum operating pressure at hydraulically most remote fire hose valve is to be **[100 psig (690 kPa)] <Insert pressure>**.
 - b. Name of hydraulic program used.
 - c. Water supply information, including fire hydrant flow test data report.
3. Submit documents and calculations **[signed and sealed by qualified professional engineer responsible for their preparation] [and] [prepared by NICET Level III-certified technician, "Water-Based Systems Layout." [prepared by NICET Level IV-certified technician, "Water-Based Systems Layout." [NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.]**
4. Include diagrams for power, signal, and control wiring.

- D. Delegated Design Submittals: For fire-suppression systems indicated to comply with performance requirements and design criteria, including analysis data, **[signed and sealed by the qualified professional engineer responsible for their preparation.] [prepared by NICET Level III-certified technician, "Water-Based Systems Layout." [prepared by NICET Level IV-certified technician, "Water-Based Systems Layout." [NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.]**

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Fire-suppression system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.
- B. Seismic Qualification Certificates: For fire-suppression equipment, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For qualified Installer[**and professional engineer**] [**and NICET-certified technician**].
- D. Design Data: Approved fire-suppression piping working plans, prepared in accordance with [NFPA 13] [and] [NFPA 14], including documented approval by AHJs, and including hydraulic calculations if applicable.
- E. Welding certificates.
- F. Field Test Reports:
1. Indicate and interpret test results for compliance with performance requirements and as described in [NFPA 13] [and] [NFPA 14]. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 2. Fire-hydrant flow test report.
- G. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-suppression systems and specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.
 2. System control valves.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by [qualified professional engineer.] [NICET Level III-certified

technician, "Water-Based Systems Layout." [NICET Level IV-certified technician, "Water-Based Systems Layout."]

- B. Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Fire-Suppression Service: Do not interrupt fire-suppression service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression service in accordance with requirements indicated:
 - 1. Notify [Architect] [Construction Manager] [Owner] no fewer than [seven] <Insert number> days in advance of proposed interruption of fire-suppression service.
 - 2. Do not proceed with interruption of fire-suppression service without [Architect's] [Construction Manager's] [Owner's] written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Automatic wet-type, [Class I] [Class II] [Class III] standpipe system.
- B. Automatic dry-type, [Class I] [Class II] [Class III] standpipe system.
- C. Semiautomatic dry-type, [Class I] [Class II] [Class III] standpipe system.
- D. Manual wet-type, Class I standpipe system.
- E. Manual dry-type, Class I standpipe system.
- F. Automatic combination wet-type standpipe sprinkler system.
- G. Automatic wet-pipe sprinkler system.
- H. Automatic dry-pipe sprinkler.
- I. Automatic deluge sprinkler system.
- J. Automatic single-interlock preaction sprinkler system.
- K. Automatic double-interlock preaction sprinkler system.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-suppression system piping to withstand the effects of earthquake motions determined in accordance with [NFPA 13] [NFPA 14] [and] [ASCE/SEI 7] <Insert

standard>. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

- B. Fire-Suppression System Components, Devices, and Accessories: Listed in UL's "Fire Protection Equipment Directory" and FM Approvals' "Approval Guide."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Fire-suppression system equipment, specialties, accessories, installation, and testing to comply with **[NFPA 13] [NFPA 13R] [NFPA 14] [NFPA 13D] [and] [ASME A17.1] <Insert standard>**.
- E. Standard-Pressure Piping System Component: Listed for 175 psig (1200 kPa) minimum working pressure.
- F. High-Pressure Piping System Component: Listed for **[250 psig (1725 kPa) minimum] [300 psig (2070 kPa)]** working pressure.
- G. Delegated Design: Engage a **[qualified professional engineer] [NICET Level III-certified technician, "Water-Based Systems Layout"] [NICET Level IV-certified technician, "Water-Based Systems Layout"]** to design fire-suppression systems.

1. Fire-Hydrant Flow Test:

- a. Available fire-hydrant flow test records indicate the following conditions:
 - 1) Date: **<Insert test date>**.
 - 2) Time: **<Insert time> [a.m.] [p.m.]**
 - 3) Performed by: **<Insert operator's name> of <Insert firm>**.
 - 4) Location of Residual Fire Hydrant R: **<Insert location>**.
 - 5) Location of Flow Fire Hydrant F: **<Insert location>**.
 - 6) Static Pressure at Residual Fire Hydrant R: **<Insert psig (kPa)>**.
 - 7) Measured Flow at Flow Fire Hydrant F: **<Insert gpm (L/s)>**.
 - 8) Residual Pressure at Residual Fire Hydrant R: **<Insert psig (kPa)>**.
- b. Perform fire-hydrant flow test and record the following conditions:
 - 1) Date: **<Insert test date>**.
 - 2) Time: **<Insert time> [a.m.] [p.m.]**
 - 3) Performed by: **<Insert operator's name> of <Insert firm>**.
 - 4) Location of Residual Fire Hydrant R: **<Insert location>**.
 - 5) Location of Flow Fire Hydrant F: **<Insert location>**.
 - 6) Static Pressure at Residual Fire Hydrant R: **<Insert psig (kPa)>**.
 - 7) Measured Flow at Flow Fire Hydrant F: **<Insert gpm (L/s)>**.
 - 8) Residual Pressure at Residual Fire Hydrant R: **<Insert psig (kPa)>**.
- c. Fire-hydrant flow test must be performed within previous **[12] <Insert number>** months prior to completion of design documents and hydraulic calculations.

2. Margin of Safety for Available Water Flow and Pressure: **[10] [20] <Insert number>** percent, including losses through water-service piping, valves, and backflow preventers.
3. Sprinkler Occupancy Hazard Classifications:
 - a. Automobile Parking and Showrooms: **[Ordinary Hazard, Group 1] <Insert classification>**.
 - b. Churches: **[Light Hazard] <Insert classification>**.
 - c. Dry Cleaners: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - d. Educational: **[Light Hazard] <Insert classification>**.
 - e. Electrical Equipment Rooms: **[Ordinary Hazard, Group 1] <Insert classification>**.
 - f. Elevator Machine Room and Hoistway: **[Ordinary Hazard, Group 1] <Insert classification>**.
 - g. Exterior and Interior Loading Docks, Handling Flammable/Combustible Liquids, Hazardous Materials, or Utilized for Storage: **<Insert classification>**.
 - h. Exterior Loading Docks, Only Handling Ordinary Combustibles: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - i. General Storage Areas: **[Ordinary Hazard, Group 1] <Insert classification>**.
 - j. Hospitals, including Animal Hospitals and Veterinary Facilities: **[Light Hazard] <Insert classification>**.
 - k. Institutional: **[Light Hazard] <Insert classification>**.
 - l. Laundries: **[Ordinary Hazard, Group 1] <Insert classification>**.
 - m. Libraries, except Large Stack Rooms: **[Light Hazard] <Insert classification>**.
 - n. Libraries, Large Stack Rooms: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - o. Machine Shops: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - p. Mechanical Equipment Rooms: **[Ordinary Hazard, Group 1] <Insert classification>**.
 - q. Mercantile: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - r. Museums: **[Light Hazard] <Insert classification>**.
 - s. Nursing or Convalescent Homes: **[Light Hazard] <Insert classification>**.
 - t. Offices, including Data Processing: **[Light Hazard] <Insert classification>**.
 - u. Plastics Processing Areas: **[Extra Hazard, Group 2] <Insert classification>**.
 - v. Post Offices: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - w. Printing Plants: **[Extra Hazard, Group 1] <Insert classification>**.
 - x. Printing and Publishing: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - y. Repair Garages: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - z. Residential: **[Light Hazard] <Insert classification>**.
 - aa. Restaurant Seating Areas: **[Light Hazard] <Insert classification>**.
 - bb. Restaurant Service Areas: **[Ordinary Hazard, Group 1] <Insert classification>**.
 - cc. Solvent Cleaning Areas: **[Extra Hazard, Group 2] <Insert classification>**.
 - dd. Stages: **[Ordinary Hazard, Group 2] <Insert classification>**.
 - ee. Theaters and Auditoriums, excluding Stages and Prosceniums: **[Light Hazard] <Insert classification>**.
 - ff. Upholstering Plants: **[Extra Hazard, Group 1] <Insert classification>**.
 - gg. **<Insert occupancy and hazard classification>**.
4. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Residential (Dwelling) Occupancy: **[0.05 gpm/sq. ft. over 400 sq. ft. (2.04 mm/min. over 37.2 sq. m)] <Insert value> area.**

- b. Light-Hazard Occupancy: **[0.10 gpm/sq. ft. over 1500 sq. ft. (4.1 mm/min. over 140 sq. m)]** <Insert value> area.
 - c. Ordinary-Hazard, Group 1 Occupancy: **[0.15 gpm/sq. ft. over 1500 sq. ft. (6.1 mm/min. over 140 sq. m)]** <Insert value> area.
 - d. Ordinary-Hazard, Group 2 Occupancy: **[0.20 gpm/sq. ft. over 1500 sq. ft. (8.2 mm/min. over 140 sq. m)]** <Insert value> area.
 - e. Extra-Hazard, Group 1 Occupancy: **[0.30 gpm/sq. ft. over 2500 sq. ft. (12.2 mm/min. over 230 sq. m)]** <Insert value> area.
 - f. Extra-Hazard, Group 2 Occupancy: **[0.40 gpm/sq. ft. over 2500 sq. ft. (16.3 mm/min. over 230 sq. m)]** <Insert value> area.
 - g. Special Occupancy Hazard: As determined by AHJs.
5. Minimum Density for Deluge-Sprinkler Piping Design:
- a. Ordinary-Hazard, Group 1 Occupancy: **[0.15 gpm/sq. ft. (6.1 mm/min.)]** <Insert value> over entire area.
 - b. Ordinary-Hazard, Group 2 Occupancy: **[0.20 gpm/sq. ft. (8.2 mm/min.)]** <Insert value> over entire area.
 - c. Extra-Hazard, Group 1 Occupancy: **[0.30 gpm/sq. ft. (12.2 mm/min.)]** <Insert value> over entire area.
 - d. Extra-Hazard, Group 2 Occupancy: **[0.40 gpm/sq. ft. (16.3 mm/min.)]** <Insert value> over entire area.
 - e. Special Occupancy Hazard: As determined by AHJs.
6. Maximum protection area per sprinkler in accordance with UL listing.
7. Maximum Protection Area per Sprinkler:
- a. Residential Areas: **[400 sq. ft. (37 sq. m)]** <Insert dimension>.
 - b. Office Spaces: **[120 sq. ft. (11.1 sq. m)] [225 sq. ft. (20.9 sq. m)]** <Insert dimension>.
 - c. Storage Areas: **[130 sq. ft. (12.1 sq. m)]** <Insert dimension>.
 - d. Mechanical Equipment Rooms: **[130 sq. ft. (12.1 sq. m)]** <Insert dimension>.
 - e. Electrical Equipment Rooms: **[130 sq. ft. (12.1 sq. m)]** <Insert dimension>.
 - f. Other Areas: In accordance with **[NFPA 13] [NFPA 13R] [NFPA 13D]** recommendations unless otherwise indicated.
8. Total Combined Hose-Stream Demand Requirement: In accordance with NFPA 13 unless otherwise indicated:
- a. Light-Hazard Occupancies: **[100 gpm (6.3 L/s) for 30 minutes]** <Insert requirement>.
 - b. Ordinary-Hazard Occupancies: **[250 gpm (15.75 L/s) for 60 to 90 minutes]** <Insert requirement>.
 - c. Extra-Hazard Occupancies: **[500 gpm (31.5 L/s) for 90 to 120 minutes]** <Insert requirement>.
9. Minimum residual pressure at each hose-connection outlet is as follows:
- a. NPS 1-1/2 (DN 40) Hose Connections: **[65 psig (450 kPa)]** <Insert value>.
 - b. NPS 2-1/2 (DN 65) Hose Connections: **[100 psig (690 kPa)]** <Insert value>.

- H. Obtain documented approval of fire-suppression system design from AHJs.

2.3 FIRE-SUPPRESSION PIPING, FITTINGS, AND APPURTENANCES

A. Steel Pipe, Fittings, and Appurtenances:

1. Schedule 40 Steel Pipe: [**Galvanized-**] [**and**] [**black-**]steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.
 - a. Standards:
 - 1) UL 852.
 - 2) FM 1630.
 - b. Factory-applied exterior coating.
 - c. Factory-applied bacterial-resistant internal coating to reduce microbiologically influenced corrosion.
 - d. Pipe ends may be factory or field formed to match joining method.
2. Schedule 10 Steel Pipe: [**Galvanized-**] [**and**] [**black-**]steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.
 - a. Standards:
 - 1) UL 852.
 - 2) FM 1630.
 - b. Factory-applied exterior coating.
 - c. Factory-applied bacterial resistant internal coating to reduce microbiologically influenced corrosion.
 - d. Pipe ends may be factory or field formed to match joining method.
3. Engineered Light-Wall Steel Pipe: [**Galvanized-**] [**and**] [**black-**]steel pipe, ASTM A135/A135M or ASTM A795/A795M with wall thickness less than Schedule 40. Outside dimension is to be equivalent to Schedule 40.
 - a. Standards:
 - 1) UL 852.
 - 2) FM 1630.
 - b. Factory-applied exterior coating.
 - c. Factory-applied bacterial-resistant internal coating to reduce microbiologically influenced corrosion.
 - d. Pipe ends may be factory or field formed to match joining method.
4. Steel Pipe Nipples: [**Galvanized**] [**and**] [**black**] steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
5. Steel Couplings: [**Galvanized**] [**and**] [**uncoated**] steel, ASTM A865/A865M, threaded.
6. Gray-Iron Threaded Fittings: [**Galvanized**] [**and**] [**uncoated**] gray-iron threaded fittings, ASME B16.4, Class 125, standard pattern.

7. Malleable- or Ductile-Iron Unions: ASME B16.3.
 8. Cast-Iron Flanges: ASME B16.1, Class 125.
 9. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - a. Pipe-Flange Gasket Materials: **[AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick] [ASME B16.21, nonmetallic and asbestos free] [or] [EPDM rubber gasket]**.
 - 1) Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - 2) Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - b. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.
 10. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
 - a. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 11. Plain-End-Pipe Fittings:
 - a. Pressure Rating: **[175 psig (1200 kPa)] [250 psig (1725 kPa)] [300 psig (2070 kPa)]** minimum.
 - b. Plain-End Fittings for Steel Piping: **[Galvanized] [Painted] [Uncoated]** plain-end fittings, ASTM A53/A53M, carbon steel or ASTM A106/A106M, forged steel with dimensions matching steel pipe.
 - c. Plain-End-Pipe Couplings for Steel Piping: Rigid pattern for steel-pipe dimensions, ductile-iron or malleable-iron housing. Include EPDM-rubber gasket, and bolts and nuts.
 12. Grooved-Joint, Steel-Pipe Appurtenances:
 - a.
 - b. Pressure Rating: **[175 psig (1200 kPa)] [250 psig (1725 kPa)] [300 psig (2070 kPa)]** minimum.
 - c. Grooved-End Fittings for Steel Piping: **[Galvanized] [Painted] [Uncoated]** grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 - d. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
 13. Carbon Steel Pressure-Seal Fittings: UL 213, FM Approvals-approved, 175 psig (1200 kPa) pressure rating with carbon steel-, zinc-nickel-coated housing, EPDM O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
- B. Stainless Steel Pipe, Fittings, and Appurtenances:
1. Stainless Steel Pipe: ASTM A312/A312M, **[Type 304/304L] [Type 316/316L]**, Schedule 10S, dimensions conforming to ASME B36.19M.
 2. Stainless Steel Pipe Fittings: ASTM A403/A403M.

3. Fittings for Grooved-End, Stainless Steel Pipe:
 - a. Source Limitations: Obtain appurtenance for grooved-end, stainless steel pipe from single manufacturer.
 - b. Fittings for Grooved-End, Stainless Steel Pipe: Stainless steel casting with dimensions matching stainless steel pipe.
4. Mechanical Couplings for Grooved-End, Stainless Steel Pipe:
 - a. AWWA C606 for stainless steel pipe dimensions.
 - b. Stainless steel housing sections.
 - c. Stainless steel bolts and nuts.
 - d. EPDM-rubber gaskets suitable for hot and cold water.
 - e. Minimum Pressure Rating:
 - 1) NPS 8 (DN 200) and Smaller: **[600 psig (4137 kPa)]** <Insert value>.
 - 2) NPS 10 and NPS 12 (DN 250 to DN 300): **[400 psig (2758 kPa)]** <Insert value>.
 - 3) NPS 14 to NPS 24 (DN 350 to DN 600): **[250 psig (1725 kPa)]** <Insert value>.
5. Stainless Steel Piping, Pressure-Seal-Joint Fittings:
 - a. Source Limitations: Obtain pressure-seal-joint fittings from single manufacturer.
 - b. Material: **[Type 304]** **[Type 316]** stainless steel, ASTM A312/A312M.
 - c. Fittings: **[Type 304]** **[Type 316]** stainless steel with EPDM O-ring seal in each end, and FM approved for fire protection applications.

C. Copper Tube, Fittings, and Appurtenances:

1. Copper Tube, Drawn Temper: **[ASTM B88, Type K (ASTM B88M, Type A)]** **[ASTM B88, Type L (ASTM B88M, Type B)]** [and] **[ASTM B88, Type M (ASTM B88M, Type C)]**.
2. Solder-Joint Fittings, Cast Copper: ASME B16.18 pressure fittings.
3. Solder-Joint Fittings, Wrought Copper: ASME B16.22 pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. Unions, Cast Copper: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
6. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
7. Copper Tube, Mechanically Formed Tee Fitting: For forming T-branch on copper water tube.
 - a.
 - b. Description: Tee formed in copper tube in accordance with ASTM F2014.
8. Grooved, Mechanical-Joint, Copper-Tube Appurtenances:
 - a. Standard: UL 213.
 - b. Grooved-End Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
 - c. Grooved-End-Tube Couplings: To fit copper tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM-rubber gasket rated for minimum **[180 deg F (80 deg C)]** <Insert temperature> for use with ferrous housing and steel bolts and nuts; 300 psig (2070 kPa) minimum CWP pressure rating.

9. Copper-Tube, Pressure-Seal-Joint Fittings:
 - a. Fittings: Cast brass, cast bronze, or wrought copper with EPDM O-ring seal in each end.
 - b. Minimum 200 psig (1379 kPa) working-pressure rating at 250 deg F (121 deg C).

D. CPVC Pipe, Fittings, and Appurtenances:

1. CPVC Pipe: ASTM F442/F442M and UL 1821, SDR 13.5, for 175 psig (1200 kPa) rated pressure at 150 deg F (62 deg C), with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.
2. CPVC Fittings: [**UL listed**] [**or**] [**FM Approvals approved**], for 175 psig (1200 kPa) rated pressure at 150 deg F (62 deg C), socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.
 - a. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): ASTM F438 and UL 1821, Schedule 40, socket type.
 - b. NPS 2 to NPS 3 (DN 50 to DN 80): ASTM F439 and UL 1821, Schedule 80, socket type.
 - c. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
 - d. CPVC-to-Metal Transition Unions: CPVC, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
 - e. Flanges: CPVC, one or two pieces.
3. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493 solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
4. Plastic Pipe-Flange Gasket and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.4 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connection, Exposed Type:

1. Standard: UL 405.
2. Description: Exposed, projecting, for wall mounting.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Corrosion-resistant metal.
5. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Round, brass, wall type.
8. Outlet: Back, with pipe threads.
9. Number of Inlets: [**Two**] [**Three**].
10. Escutcheon Plate Marking: [**"AUTO SPKR & STANDPIPE"**] [**"STANDPIPE"**] [**"AUTO SPKR"**] <Insert marking>.
11. Finish: [**Polished chrome plated**] [**Rough brass or bronze**] [**Rough chrome plated**].
12. Outlet Size: [**NPS 4 (DN 100)**] [**NPS 6 (DN 150)**].

- B. Fire Department Connection, Flush Type:
1. Standard: UL 405.
 2. Description: Flush, for wall mounting.
 3. Pressure Rating: 175 psig (1200 kPa) minimum.
 4. Body Material: Corrosion-resistant metal.
 5. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
 6. Caps: Brass, lugged type, with gasket and chain.
 7. Escutcheon Plate: Rectangular, brass, wall type.
 8. Outlet: With pipe threads.
 9. Body Style: [**Horizontal**] [**Square**] [**Vertical**].
 10. Number of Inlets: [**Two**] [**Three**] [**Four**] [**Six**].
 11. Outlet Location: [**Back**] [**Bottom**] [**Left side**] [**Right side**] [**Top**].
 12. Escutcheon Plate Marking: ["**AUTO SPKR & STANDPIPE**"] ["**STANDPIPE**"] ["**AUTO SPKR**"] <Insert marking>.
 13. Finish: [**Polished chrome plated**] [**Rough brass or bronze**] [**Rough chrome plated**].
 14. Outlet Size: [**NPS 4 (DN 100)**] [**NPS 6 (DN 150)**] [**NPS 8 (DN 200)**].
- C. Fire Department Connection, Yard Type:
1. Standard: UL 405.
 2. Description: Exposed, freestanding.
 3. Pressure Rating: [**175 psig (1200 kPa) minimum**] [**300 psig (2070 kPa)**].
 4. Body Material: Corrosion-resistant metal.
 5. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
 6. Caps: Brass, lugged type, with gasket and chain.
 7. Escutcheon Plate: Round, brass, floor type.
 8. Outlet: Bottom, with pipe threads.
 9. Number of Inlets: [**Two**] [**Three**] [**Four**].
 10. Sleeve: [**Brass**] [**Not required**].
 11. Sleeve Height: 18 inches (460 mm).
 12. Escutcheon Plate Marking: ["**AUTO SPKR & STANDPIPE**"] ["**STANDPIPE**"] ["**AUTO SPKR**"] <Insert marking>.
 13. Finish, Including Sleeve: [**Polished chrome plated**] [**Rough brass or bronze**] [**Rough chrome plated**].
 14. Outlet Size: [**NPS 4 (DN 100)**] [**NPS 6 (DN 150)**].
- D. Fire Department Connection, Auxiliary Type:
1. Standard: UL 405.
 2. Type: [**Exposed**] [**Flush**] [**Yard (Freestanding)**].
 3. Pressure Rating: 175 psig (1200 kPa) minimum.
 4. Body Material: Corrosion-resistant metal.
 5. Inlets: Universal, threadless (Storz) connector in accordance with NFPA 1963.
 6. Caps: Corrosion-resistant metal, with gasket and chain.
 7. Escutcheon Plate: Round, brass.
 8. Outlet: Back, with pipe threads.
 9. Number of Inlets: One.
 10. Escutcheon Plate Marking: ["**AUTO SPKR & STANDPIPE**"] ["**STANDPIPE**"] ["**AUTO SPKR**"].

11. Finish: **[Polished chrome plated]** **[Polished brass]** **[Powder coat]**.
12. Outlet Size: **[NPS 4 (DN 100)]** **[NPS 6 (DN 150)]**.

2.5 HOSE CONNECTIONS AND HOSE STATIONS

A. Hose Connections, Adjustable Valve:

1. Standards:
 - a. UL 668.
 - b. UL 1468.
2. Description: Fire hose valve, with integral reducing or restricting pressure-control device, for connecting fire hose.
3. Pressure Rating: 175 psig (1200 kPa) maximum inlet.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
8. Pattern: **[Angle]** **[or]** **[gate]**.
9. Pressure-Control Device Type: Pressure **[reducing]** **[restricting]**.
10. Design Outlet Pressure Setting: **<Insert psig (kPa)>**.
11. Finish: **[Polished chrome plated]** **[Rough brass or bronze]** **[Rough chrome plated]**.

B. Hose Connections, Nonadjustable Valve:

1. Standard: UL 668.
2. Description: Fire hose valve for connecting fire hose.
3. Pressure Rating: 300 psig (2070 kPa) minimum.
4. Material: Brass or bronze.
5. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
8. Pattern: **[Angle]** **[or]** **[gate]**.
9. Finish: **[Polished chrome plated]** **[Rough brass or bronze]** **[Rough chrome plated]**.

C. Hose Stations, Rack Type, NPS 1-1/2 (DN 40):

1. Hose Rack:
 - a. Standard: UL 47.
 - b. Material: **[Brass or bronze with polished chrome-plated]** **[Steel with red-enamel]** finish.
 - c. Type: Hose-rack assembly. Include hose valve, hose rack, water-retention device, hose pins, and hose.
 - d. Operation: Semiautomatic.
 - e. Sized to hold fire hose.
2. Hose Valve:
 - a. Standards:

- 1) UL 668.
 - 2) UL 1468.
 - b. NPS 1-1/2 (DN 40), for connecting fire hose.
 - c. Type: **[Adjustable]** **[Nonadjustable]**.
 - d. Pressure-Control Device: **[Pressure reducing]** **[or]** **[pressure restricting]**, UL 1468 integral or for field installation if indicated.
 - e. Design Outlet Pressure Setting: **[Not applicable]** **<Insert psig (kPa)>**.
 - f. Hose Valve and Trim Finish: **[Polished chrome-plated]** **[Rough brass or bronze]** **[Rough chrome-plated]**.
 - g. Pressure Rating: 300 psig (2070 kPa) minimum.
 - h. Pattern: Angle.
 - i. Material: Brass or bronze.
 - j. Size: NPS 1-1/2 (DN 40).
 - k. Inlet: Female pipe threads.
 - l. Outlet: Male hose threads in accordance with NFPA 1963 and matching local fire department threads.
3. Hose:
 - a. Standards:
 - 1) NFPA 1961.
 - 2) UL 219.
 - 3) UL 401.
 - b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
 - c. Size: NPS 1-1/2 (DN 40).
 - d. Length: **[50 ft. (15 m)]** **[75 ft. (23 m)]** **[100 ft. (30 m)]** **<Insert dimension>**.
 - e. Jacket: **[Combination of natural and synthetic threads]** **[Natural thread]** **[Synthetic thread]**.
 - f. Lining: **[Rubber, plastic, or combination of rubber and plastic compounds]** **[Combination of rubber and plastic compounds]** **[Rubber compound]** **[Plastic compound]**.
 - g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
 - h. Nozzle:
 - 1) Material: **[Brass]** **[Polished brass]** **[Rough chrome-plated brass]** **[Polished chrome-plated brass]** **[Polycarbonate plastic]**.
 - 2) Type: **[Plain, for nonadjustable water stream]** **[Spray, adjustable from shutoff to fog spray or straight stream]** **[Spray, adjustable from shutoff to full fog; for use on electrical fires]**.
- D. Hose Stations, Rack Type, NPS 1-1/2 by NPS 2-1/2 (DN 40 by DN 65):
 1. Hose Rack:
 - a. Standard: UL 47.
 - b. Material: **[Brass or bronze with polished chrome-plated]** **[Steel with red-enamel]** finish.
 - c. Type: Hose-rack assembly. Include hose valve, reducer adapter, hose rack, water-retention device, hose pins, and hose.

- d. Operation: Semiautomatic.
 - e. Sized to hold fire hose.
2. Hose Valve:
- a. Standards:
 - 1) UL 668.
 - 2) UL 1468.
 - 3) NFPA 1963.
 - b. NPS 2-1/2 (DN 65), for connecting fire hose.
 - c. Type: **[Adjustable] [Nonadjustable]**.
 - d. Pressure-Control Device: **[Pressure reducing] [or] [pressure restricting]**, UL 1468 integral or for field installation if indicated.
 - e. Design Outlet Pressure Setting: **[Not applicable] <Insert psig (kPa)>**.
 - f. Hose Valve and Trim Finish: **[Polished chrome plated] [Rough brass or bronze] [Rough chrome plated]**.
 - g. Pressure Rating: 300 psig (2070 kPa) minimum.
 - h. Pattern: Angle.
 - i. Material: Brass or bronze.
 - j. Size: NPS 2-1/2 (DN 65).
 - k. Inlet: Female pipe threads.
 - l. Outlet: Male hose threads and matching local fire department threads.
 - m. Reducer Adapter: NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40).
3. Hose:
- a. Standards:
 - 1) UL 219.
 - 2) UL 401.
 - 3) NFPA 1961.
 - b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
 - c. Size: NPS 1-1/2 (DN 40).
 - d. Length: **[50 ft. (15 m)] [75 ft. (23 m)] [100 ft. (30 m)] <Insert dimension>**.
 - e. Jacket: **[Combination of natural and synthetic threads] [Natural thread] [Synthetic thread]**.
 - f. Lining: **[Rubber, plastic, or combination of rubber and plastic compounds] [Combination of rubber and plastic compounds] [Rubber compound] [Plastic compound]**.
 - g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
 - h. Nozzle: Spray nozzle unless plain nozzle is indicated.
 - 1) Material: **[Brass] [Polished brass] [Rough chrome-plated brass] [Polished chrome-plated brass] [Polycarbonate plastic]**.
 - 2) Type: **[Plain, for nonadjustable water stream] [Spray, adjustable from shutoff to fog spray or straight stream] [Spray, adjustable from shutoff to full fog; for use on electrical fires]**.

E. Hose Stations, Reel Type, NPS 1-1/2 (DN 40):

1. Hose Reel:

- a. Standard: UL 47.
- b. Hose Reel and Bracket Material: Steel.
- c. Description: Hose-reel assembly. Include hose valve, wall bracket, hose reel, water-retention device, hose pins, and hose.
- d. Operation: Semiautomatic.
- e. Sized to hold fire hose.
- f. Finish: Red enamel.

2. Hose Valve:

a. Standards:

- 1) UL 668.
- 2) UL 1468.
- 3) NFPA 1963.

- b. NPS 1-1/2 (DN 40), for connecting fire hose.
- c. Type: **[Adjustable]** **[Nonadjustable]**.
- d. Pressure-Control Device: **[Pressure reducing]** **[or]** **[pressure restricting]**, UL 1468 integral or for field installation if indicated.
- e. Design Outlet Pressure Setting: **[Not applicable]** **<Insert psig (kPa)>**.
- f. Hose Valve and Trim Finish: **[Polished chrome plated]** **[Rough brass or bronze]** **[Rough chrome plated]**.
- g. Pressure Rating: 300 psig (2070 kPa) minimum.
- h. Pattern: Angle.
- i. Material: Brass or bronze.
- j. Size: NPS 1-1/2 (DN 40).
- k. Inlet: Female pipe threads.
- l. Outlet: Male hose threads and matching local fire department threads.

3. Hose:

a. Standards:

- 1) UL 219.
- 2) UL 401.
- 3) NFPA 1961.

- b. Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
- c. Size: NPS 1-1/2 (DN 40).
- d. Length: **[50 ft. (15 m)]** **[75 ft. (23 m)]** **[100 ft. (30 m)]** **<Insert dimension>**.
- e. Jacket: **[Combination of natural and synthetic threads]** **[Natural thread]** **[Synthetic thread]**.
- f. Lining: **[Rubber, plastic, or combination of rubber and plastic compounds]** **[Combination of rubber and plastic compounds]** **[Rubber compound]** **[Plastic compound]**.
- g. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
- h. Nozzle:

- 1) Material: [**Brass**] [**Polished brass**] [**Rough chrome-plated brass**] [**Polished chrome-plated brass**] [**Polycarbonate plastic**].
- 2) Type: Spray, adjustable from shutoff to [**fog spray or straight stream**] [**full fog; for use on electrical fires**].

2.6 SYSTEM CONTROL VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
- B. Pressure Rating:
 1. Standard-Pressure Piping Valves: 175 psig (1200 kPa) minimum.
 2. High-Pressure Piping Valves: [**250 psig (1725 kPa) minimum**] [**300 psig (2070 kPa)**].
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. System Control Valve, Alarm Valve:
 1. Standard: UL 193.
 2. Design: For horizontal or vertical installation.
 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, [**retarding chamber**], and fill-line attachment with strainer.
 4. Drip cup assembly pipe drain [**without valves and separate from main drain piping**] [**with check valve to main drain piping**].
- G. System Control Valve, Dry-Pipe Valve:
 - 1.
 2. Standards:
 - a. UL 260.
 - b. UL 1486.
 3. Design: Differential-pressure type.
 4. Include quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
 5. Air-Pressure Maintenance Device for Dry-Pipe Valve:
 - a. Standard: UL 260.
 - b. Description: Automatic device to maintain minimum air pressure in piping.
 - c. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14 to 60 psig (95 to 410 kPa) adjustable range, and [**175 psig (1200 kPa)**] [**300 psig (2070 kPa)**] outlet pressure.
 6. Air Compressor for Dry-Pipe Valve:
 - a. Motor Horsepower: Fractional.

- b. Power: 120 V ac, 60 Hz, single phase.
 - c. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA standards. Provide ASME air receiver tank as required to meet requirements on larger systems.
 - d. Include filters, relief valves, coolers, automatic drains, and gauges.
- H. System Control Valve, Deluge Valve:
 - 1. Standard: UL 260.
 - 2. Design: Hydraulically operated, differential-pressure type.
 - 3. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
 - 4. Wet, Pilot-Line Trim Set: Include gauge to read diaphragm-chamber pressure and manual control station for manual operation of deluge valve, and connection for actuation device.
- I. System Control Valve, Preaction Valve:
 - 1. Standard: UL 260.
 - 2. Design: Hydraulically operated, differential-pressure type.
 - 3. Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
 - 4. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gauges; low-air-pressure warning switch; air-relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
 - 5. Air-Pressure Maintenance Device for Preaction Valve:
 - a. Standard: UL 260.
 - b. Description: Automatic device to maintain minimum air pressure in piping.
 - c. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14 to 60 psig (95 to 410 kPa) adjustable range, and **[175 psig (1200 kPa)] [300 psig (2070 kPa)]** outlet pressure.
 - 6. Air Compressor for Preaction Valve:
 - a. Motor Horsepower: Fractional.
 - b. Power: 120 V ac, 60 Hz, single phase.
 - c. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA standards. Provide ASME air receiver tank as required to meet requirements on larger systems.
 - d. Include filters, relief valves, coolers, automatic drains, and gauges.

2.7 DRY-SPRINKLER SYSTEM NITROGEN GENERATOR WITH PURGE/VENT

- A. Description: Nitrogen generator system to serve dry sprinkler zones for piping corrosion mitigation, including system venting. System is to provide required supervisory pressure within sprinkler zone. System is to include either an integrated, oil-less air compressor, located within the nitrogen generator system package, or a separate vibration-isolation mounted air compressor, also provided by nitrogen generator manufacturer.

B. Standards:

1. FM 1035.
2. UL 508A.

C. Nitrogen Generator:

1. **[Wall-mounted] [skid-mounted] [or] [stand-alone]** nitrogen generator to provide minimum nitrogen purity of 98 percent to the designated sprinkler systems.
2. Power: 120 V ac.
3. Bypass mode and nitrogen-generating mode.
4. Minimum Capacity: **[As recommended by manufacturer] <Insert requirements>**.

D. Air Compressor:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
2. Motor Horsepower: Fractional.
 - a. Power: 120 V ac, 60 Hz, single phase.
3. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
4. Include filters, relief valves, coolers, automatic drains, and gauges.
5. Minimum Capacity: Match capacity of nitrogen generator.

E. Automatic Purge Vent/Valve:

1. Vents oxygen during system nitrogen fill.
2. Automatically closes when 98 percent minimum nitrogen has been reached.
3. Sized to allow correct purge rate per manufacturer's written instructions and with **[14 days] <Insert period>**.
4. Provide one venting device for each dry/preaction sprinkler system zone.
5. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.

F. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:

1. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of the automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.
2. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.

G. BAS Alarm Integration:

1. Provide nitrogen-generation system with integrated leak-detection and bypass alarms. Program alarms into controller[**and connect to BAS**].

- a. Leak-detection system is to alarm if leaks develop within fire-suppression system piping.
- b. Air bypass alarm is to activate if nitrogen-generation system is bypassed by air compressor.

2.8 PREACTION SPRINKLER SYSTEM NITROGEN GENERATOR WITH PURGE/VENT

- A. Description: Nitrogen generator system to serve preaction sprinkler zones for piping corrosion mitigation, including system venting. System is to provide required supervisory pressure within sprinkler zone. System is to include either an integrated, oil-less air compressor, located within the nitrogen generator system package, or a separate vibration-isolation mounted air compressor, also provided by nitrogen generator manufacturer.
- B. Standards:
 1. FM 1035.
 2. UL 508A.
- C. Nitrogen Generator:
 1. **[Wall-mounted] [skid-mounted] [or] [stand-alone]** nitrogen generator to provide minimum nitrogen purity of 98 percent to the designated sprinkler systems.
 2. Power: 120 V ac.
 3. Bypass mode and nitrogen-generating mode.
 4. Minimum Capacity: **[As recommended by manufacturer] <Insert requirements>**.
- D. Air Compressor:
 1. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
 2. Motor Horsepower: Fractional.
 - a. Power: 120 V ac, 60 Hz, single phase.
 3. Sized for application and capable of achieving system supervisory pressure within 30 minutes in accordance with requirements of NFPA 13. Provide ASME air receiver tank as required to meet requirements on larger systems.
 4. Include filters, relief valves, coolers, automatic drains, and gauges.
 5. Minimum Capacity: Match capacity of nitrogen generator.
- E. Automatic Purge Vent/Valve:
 1. Vents oxygen during system nitrogen fill.
 2. Automatically closes when 98 percent minimum nitrogen has been reached.
 3. Sized to allow correct purge rate per manufacturer's written instructions and with **[14 days] <Insert period>**.
 4. Provide one venting device for each dry/preaction sprinkler system zone.
 5. Include a connection port for a portable nitrogen purity sensor or a nitrogen purity manifold.

F. Supervisory Gas Monitoring - Nitrogen Purity Sensing Device:

1. Portable Handheld Nitrogen Purity Sensing Device: Portable sensing device to connect to the outlet of automatic purge/vent valve during periodic inspections to obtain a nitrogen purity reading within each zone.
2. Permanently Mounted Nitrogen Purity Monitoring Device or Manifold: Permanent monitoring device to continuously monitor system's nitrogen purity.

G. BAS Alarm Integration:

1. Provide nitrogen-generation system with integrated leak-detection and bypass alarms. Program alarms into controller[**and connect to BAS**].
 - a. Leak-detection system is to alarm if leaks develop within fire-suppression system piping.
 - b. Air bypass alarm is to alarm if nitrogen-generation system is bypassed by air compressor.

2.9 FIRE-SUPPRESSION PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: [**175 psig (1200 kPa) minimum**] [**300 psig (2070 kPa)**].
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
2. Pressure Rating: [**175 psig (1200 kPa) minimum**] [**300 psig (2070 kPa)**].
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

- 1.
2. Standard: UL 199.
3. Pressure Rating: 175 psig (1200 kPa).
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

- D. Sprinkler Inspector's Test Fittings:
 - 1. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
 - 2. Pressure Rating: **[175 psig (1200 kPa) minimum] [300 psig (2070 kPa)]**.
 - 3. Body Material: Cast- or ductile-iron housing with sight glass.
 - 4. Size: Same as connected piping.
 - 5. Inlet and Outlet: Threaded.
- E. Adjustable Drop Nipples:
 - 1. Standard: UL 1474.
 - 2. Pressure Rating: **[250 psig (1725 kPa) minimum] [300 psig (2070 kPa)]**.
 - 3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - 4. Size: Same as connected piping.
 - 5. Length: Adjustable.
 - 6. Inlet and Outlet: Threaded.
- F. Flexible Sprinkler Hose Fittings:
 - 1. Standards:
 - a. UL 2443.
 - b. FM 1637.
 - 2. Description: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 - 3. Pressure Rating: **[175 psig (1200 kPa) minimum] [300 psig (2070 kPa)]**.
 - 4. Size: Same as connected piping, for sprinkler.
- G. Automatic (Ball-Drip) Drain Valves:
 - 1. Pressure Rating: 175 psig (1200 kPa) minimum.
 - 2. Type: Automatic draining, ball check.
 - 3. Size: NPS 3/4 (DN 20).
 - 4. End Connections: Threaded.
- H. Manual Air Vent/Valve:
 - 1. Description: Ball valve that requires human intervention to vent air.
 - 2. Body: Forged brass.
 - 3. Ends: Threaded.
 - 4. Minimize Size: 1/2 inch (13 mm).
 - 5. Minimum Water Working Pressure Rating: 300 psig (2070 kPa).
- I. Automatic Air Vent:
 - 1. Description: Automatic air vent that automatically vents trapped air without human intervention. Approved for use in wet-pipe fire-suppression system.
 - 2. Vents oxygen continuously from system.
 - 3. Float valve to prevent water discharge.
 - 4. Minimum Water Working Pressure Rating: 175 psig (1207 kPa).
- J. Automatic Air Vent Assembly:
 - 1. Description: Automatic **[dual]** air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly. Approved for use in wet-pipe fire-suppression system.

2. Vents oxygen continuously from system.
3. Float valve to prevent water discharge.
4. Minimum Water Working Pressure Rating: 175 psig (1207 kPa).
5. **<Insert additional requirements specific to manufacturers>.**

2.10 COVER SYSTEMS FOR SPRINKLER PIPING

- A. Cover System, Extruded PVC:
 1. Description: System of support brackets and covers designed to protect sprinkler piping.
 2. Brackets: Per cover manufacturer.
 3. Covers: Factory-fabricated extruded-PVC cover with concealed attachment clips.
- B. Cover System, Fabricated Steel:
 1. Description: System of support brackets and covers designed to protect sprinkler piping.
 2. Brackets: Per cover manufacturer.
 3. Covers: Factory-fabricated steel cover with concealed attachment clamps.
 - a. Stainless Steel with #4 Finish: [16] [18] [20] [22] [24] gauge.
 - b. Cold-Rolled Steel: [18] [20] [22] [24] gauge.
 - 1) Zinc-galvanized treated to accept painting but not painted.
 - 2) Zinc galvanized, factory treated, and factory painted in colors selected by Architect from manufacturers standard/custom colors.
 - 3) Zinc galvanized, factory treated, and factory primed.

2.11 SPRINKLERS

- A. Standards:
 1. UL 199.
 2. UL 1767.
 3. UL 1626.
 4. FM 2000.
 5. FM 2008.
 6. FM 2030.
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
- C. Pressure Rating for Sprinklers:
 1. Standard Automatic Sprinklers: 175 psig (1200 kPa) minimum.
 2. High-Pressure Automatic Sprinklers: **[250 psig (1725 kPa) minimum] [300 psig (2070 kPa)].**
 3. Residential Sprinklers: 175 psig (1200 kPa) maximum.
- D. Sprinklers, Automatic Wet with Heat-Responsive Element:

1. Characteristics: Nominal 1/2-inch (13-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
 2. Standard Spray, Standard Response:
 - a. Upright.
 - b. Pendent.
 - c. Recessed pendent.
 - d. Flat, concealed pendent.
 - e. Vertical sidewall.
 - f. Horizontal sidewall.
 3. Standard Spray, Quick Response:
 - a. Upright.
 - b. Pendent.
 - c. Recessed pendent.
 - d. Flat, concealed pendent.
 - e. Vertical sidewall.
 - f. Horizontal sidewall.
 - g. Flat, concealed horizontal sidewall.
 4. Extended Coverage:
 - a. Upright.
 - b. Pendent.
 - c. Flat, concealed pendent.
 - d. Horizontal sidewall.
 - e. Flat, concealed horizontal sidewall.
 5. Residential:
 - a. Recessed pendent.
 - b. Flat, concealed pendent.
 - c. Flat, concealed horizontal sidewall.
- E. Sprinklers, Automatic Dry with Heat-Responsive Element:
1. Standard Spray, Standard Response:
 - a. Upright.
 - b. Pendent.
 - c. Recessed pendent.
 - d. Flat, concealed pendent.
 - e. Horizontal sidewall.
 2. Standard Spray, Quick Response:
 - a. Upright.
 - b. Pendent.
 - c. Recessed pendent.

- d. Flat, Concealed pendent.
- e. Horizontal sidewall.
- f. Flat, concealed horizontal sidewall.

F. Special Sprinklers:

- 1. Attic.
- 2. Combustible, concealed.
- 3. ESFR.
- 4. Flat spray.
- 5. Hallway.
- 6. Institutional.
- 7. MRI/Non-Ferrous, concealed.
- 8. Window.

G. Open Sprinklers and Nozzles:

- 1. Nominal Orifice:
 - a. 1/2 inch (13 mm), with discharge coefficient K between [5.3 and 5.8] <Insert value>.
 - b. 17/32 inch (13.5 mm) with discharge coefficient K between [7.4 and 8.2] <Insert value>.

H. Sprinkler Finishes: [**Chrome plated**] [**bronze**] [**and**] [**painted**].

I. Special Coatings: [**Wax**] [**lead**] [**and**] [**corrosion-resistant paint**].

J. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

- 1. Ceiling Mounting: [**Chrome-plated steel, one piece, flat**] [**Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment**] [**Plastic, white finish, one piece, flat**].
- 2. Sidewall Mounting: [**Chrome-plated steel**] [**Plastic, white finish**], one piece, flat.

K. Sprinkler Guards and Water Shields:

- 1. Standard: UL 199.
- 2. Description: Wire cage with fastening device for attaching to sprinkler.

2.12 ALARM DEVICES

A. Match alarm-device material and connection types to piping and equipment materials and connection types.

B. Water-Motor-Operated Alarm:

- 1. Standard: UL 753.
- 2. Type: Mechanically operated, with Pelton wheel.
- 3. Alarm Gong: Cast aluminum with red-enamel factory finish.

4. Size: **[8-1/2-inch (216-mm)] [10-inch (250-mm)] [Insert diameter]** diameter.
 5. Components: Shaft length, bearings, and sleeve to suit wall construction.
 6. Inlet: NPS 3/4 (DN 20).
 7. Outlet: NPS 1 (DN 25) drain connection.
- C. Electrically Operated Notification Appliances:
1. Electric Bell:
 - a. Standard: UL 464.
 - b. Type: Vibrating, metal alarm bell.
 - c. Size: **[6-inch (150-mm) minimum-] [8-inch (200-mm) minimum-] [10-inch (250-mm)]** diameter.
 - d. Voltage: **[120 V ac, 60 Hz, single phase] [24 V dc]**.
 - e. Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
 2. Strobe/Horn:
 - a. Standard: UL 464.
 - b. Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
 - c. Voltage: 120 V ac, 60 Hz.
 - d. Effective Intensity: 110 cd.
 - e. Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
 - f. Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police or fire department.
- D. Water-Flow Indicators:
1. Standard: UL 346.
 2. Water-Flow Detector: Electrically supervised.
 3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 4. Type: Paddle operated.
 5. Pressure Rating: 250 psig (1725 kPa).
 6. Design Installation: Horizontal or vertical.
- E. Pressure Switches - Water-Flow Alarm Detection:
1. Description: Electrically supervised, pressure-activated water-flow switch with retard feature.
 2. Components: Two single-pole, double-throw switches with normally closed contacts.
 3. Design Operation: Rising pressure to **[6 psi (40 kPa), plus or minus 2 psi (13.8 kPa)]** **<Insert value>** signals water flow.
 4. Adjustability: Each switch is to be independently adjustable.

5. Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.
- F. Pressure Switches - Low/High Air Pressure Supervisory:
1. Description: Electrically supervised pressure supervisory switch.
 2. Components: Two single-pole, double-throw switches.
 3. Design Operation: Detects increase and/or decrease from normal supervisory air pressure.
 4. Adjustability: Each switch is to be independently adjustable.
 5. Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.
- G. Valve Supervisory Switches:
1. Standard: UL 346.
 2. Type: Electrically supervised.
 3. Design: Signals that controlled valve is in other than fully open position.
 4. Wire Terminal Designations: Indicates normal switch position when switch is properly installed on valve and valve is fully open.
 5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. OS&Y Valve Supervisory Switches:
 - a. One or two single-pole, double-throw switches.
 - b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
 - c. Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully open.
 - d. Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
 - e. Trip Rod Length: Adjustable
 7. Butterfly Valve Supervisory Switches:
 - a. Two single-pole, double-throw switches.
 - b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
 - c. Mounting Hardware: Removable nipple.
 - d. Trip Rod Length: Adjustable
 8. Ball Valve Supervisory Switches:
 - a. One single-pole, double-throw switch.
 - b. NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.
 - c. Mounting Hardware: Suitable for mounting directly to pipe, ball valves, or backflow preventers sized from up to NPS 2 (DN 50).
- H. Indicator-Post Supervisory Switches:
1. Type: Electrically supervised.

2. Components: Single-pole, double-throw switch with normally closed contacts.
3. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.13 MANUAL CONTROL STATIONS

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide"
- B. Description: For hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve.
- C. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.14 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
 1. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
 2. Electrical characteristics are 120 V ac, 60 Hz, with 24 V dc rechargeable batteries.
 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Manual Control Stations, Electric Operation: Metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- C. Manual Control Stations, Hydraulic Operation: Provide union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- D. Panel Components:
 1. Power supply.
 2. Battery charger.
 3. Standby batteries.
 4. Field-wiring terminal strip.
 5. Electrically supervised solenoid valves and polarized fire-alarm bell.
 6. Lamp test facility.
 7. Single-pole, double-throw auxiliary alarm contacts.
 8. Rectifier.

2.15 PRESSURE GAUGES

- A. Standard: UL 393.

- B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- C. Pressure Gauge Range: **[0 to 250 psig (0 to 1725 kPa) minimum] [0 to 300 psig (0 to 2070 kPa)]**.
- D. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gauge: Include **[retard feature and]** "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article.
 - 1. Flow test is to be performed to meet the criteria established by **[NFPA 13] [and] [NFPA 14]**.
 - 2. Flow test is to be conducted in accordance with NFPA 291.
 - 3. Test is to be performed during a period of ordinary demand for the water system.
 - a. To obtain satisfactory test results of expected flow or rated capacities, sufficient discharge should be achieved to cause drop of at least 10 percent.
 - 4. Pitot readings are to be taken at the 2-1/2-inch (65-mm) orifice connection.
 - 5. The pitot reading is to range from 10 to 35 psig (68.9 kPa to 241.3 kPa).
 - 6. Open additional hydrant outlets as needed to control pitot readings.
 - 7. The pitot pressure and corresponding residual pressure readings are to be taken consecutively as pressure fluctuates between a high number and low number.
- B. Flow Test Data Written Report:
 - 1. Flow data report is to be written in accordance with NFPA 291.
 - 2. Flow data report is to include a copy of all flow data recorded during the test, including a site plan showing the tested fire hydrants with respect to the fire water service to the building. Site plan is to indicate which hydrant was flowed and which hydrant was used for pressure reading. Provide date of test, name of testing agency, and name of individual performing test.
- C. Water Supply Curve: Provide water supply curve based on the lowest supply for a given set of test data. For a given residual pressure reading, the supply is to be graphed utilizing the corresponding pitot pressure/flow reading and static pressure reading.
- D. Documentation is to include calibration certifications for gauges used in the flow tests. The certifications are to be from within the previous six (6) months from a reputable agency recognized for certifying pressure gauges.
- E. Report flow test results promptly and in writing. A copy of the flow test data report is to be submitted with the hydraulic calculations.

3.2 INSTALLATION OF FIRE-SUPPRESSION WATER-SERVICE PIPING

- A. Comply with requirements for fire-suppression water-service piping in Section 331415 "Site Water Distribution Piping."

3.3 INSTALLATION OF DOMESTIC WATER-SUPPLY CONNECTIONS

- A. Connect fire-suppression water piping to building's interior domestic water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 331415 "Site Water Distribution Piping."

3.4 INSTALLATION OF FIRE-SUPPRESSION PIPING

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from AHJs. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with [NFPA 13] [and] [NFPA 14] requirements for installation of fire-suppression piping.
- C. Install seismic restraints on piping. Comply with NFPA standards requirements for seismic-restraint device materials and installation.
- D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install inspector's test connections in sprinkler system piping, complete with shutoff valve, and sized and located in accordance with NFPA 13.
- H. Install fire-suppression system piping with drains for complete system drainage. Extend drain piping to exterior of building where possible.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire department connection, to drain piping between fire department connection and check valve. Install drain piping to and spill over floor drain or to exterior of building.

- K. Install alarm devices in piping systems.
- L. Install hangers and supports for fire-suppression piping in accordance with NFPA standards. Comply with requirements for hanger materials in NFPA standards. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe/sprinkler supply. Include pressure gauges with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- N. Pressurize and check [**dry-pipe**] [**preaction**] standpipe or sprinkler system piping and [**air-pressure maintenance devices**] [**air compressors**].
- O. Fill wet-type fire-suppression system piping with water.
- P. Drain dry-type fire-suppression system piping.
 - 1. Install electric heating cables and pipe insulation on fire-suppression piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210500 "Common Work Results for Fire-Suppression Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210500 "Common Work Results for Fire-Suppression Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210500 "Common Work Results for Fire-Suppression Piping."

3.5 INSTALLATION OF PIPING JOINTS

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts in accordance with ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.
- M. Brazed Joints: Join copper tube and fittings in accordance with Copper Development Association's "Copper Tube Handbook," "Braze Joints" chapter.
- N. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.
- O. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- P. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- Q. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- R. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M Appendix.

3.6 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

- A. Install wall-type fire department connections.
- B. Install yard-type fire department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."
- C. Install [two] [three] <Insert number> protective pipe bollards [around] [on sides of] each fire department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."
- D. Install automatic (ball-drip) drain valve at each check valve for fire department connection.

3.7 INSTALLATION OF HOSE CONNECTIONS AND HOSE STATIONS

- A. Examine roughing-in for hose connections and hose stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and hose stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Install hose connections adjacent to standpipes.
- E. Install freestanding hose connections and hose stations for access and minimum passage restriction.
- F. Install NPS 1-1/2 (DN 40) hose-connection and hose-station valves with flow-restricting device unless otherwise indicated.
- G. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device unless otherwise indicated.
- H. Install wall-mounted-type hose connections and wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Section 104413 "Fire Protection Cabinets."
- I. Install freestanding hose stations with support or bracket attached to standpipe.
- J. Install hose-reel hose stations on wall with bracket.

3.8 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping in accordance with manufacturer's installation manual and in accordance with NFPA 13 or NFPA 13R for supports.

3.9 INSTALLATION OF VALVES AND SPECIALTIES

- A. Install listed fire-suppression system control valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with manufacturer's installation instructions, NFPA standards, and AHJ.
- B. Install listed fire-suppression system shutoff valves in supervised open position, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. System Control Valves:
 - 1. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
 - 2. Install [**dry-pipe**] [**and**] [**preaction**] valves with trim sets for air supply, drain, priming level, alarm connections, ball-drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
 - a. Install air compressor and compressed-air-supply piping.
 - b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with [**14 to 60 psig (95 to 410 kPa)**] **<Insert value>** adjustable range; and [**175 psig (1200 kPa)**] **<Insert value>** maximum inlet pressure.
 - c. Install compressed-air-supply piping from building's compressed-air piping system.
 - 3. Install deluge valves with trim sets for drain, priming level, alarm connections, ball-drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
- D. Air Vent:
 - 1. Provide at least one air vent at high point in each wet-pipe fire-suppression system in accordance with NFPA standards. Connect vent into top of fire-suppression piping.
 - 2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
 - 3. Pipe from outlet of air vent to drain.

3.10 INSTALLATION OF SPRINKLERS

- A. Install sprinklers in suspended ceilings symmetrically in center of [**narrow dimension of**] acoustical ceiling panels within tolerance of [**1/2 inch (12.7 mm)**] **<Insert dimension>**. Coordinate entire pattern of sprinkler locations with approved reflected ceiling plan.

- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.11 INSTALLATION OF NITROGEN GENERATOR WITH PURGE/VENT SYSTEM

- A. Install in accordance with manufacturer's written installation instructions.
- B. Locate purge vent/valve in accordance with manufacturer's written installation instructions.
- C. Route alarm signals in code-approved electrical conduit from nitrogen generator system control panel to the supervisory circuit of BAS.

3.12 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping in accordance with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect fire-suppression systems in accordance with NFPA standards.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Start and run air compressors.
 - 6. Coordinate with fire-alarm tests. Operate as required.
 - 7. Coordinate with fire-pump tests. Operate as required.
 - 8. Verify that equipment hose threads are same as local fire department equipment.
 - 9. Verify that sprinklers original factory finish has not been contaminated with dirt, debris, or paint. Sprinklers containing other-than-original factory finish are to be considered defective and replaced with new products. Repair and/or cleaning is not acceptable.
- C. Fire-suppression piping system will be considered defective if it does not pass tests and inspections.

- D. Fire-suppression piping system components considered defective during testing will be replaced with new components. Repair of defective components is not acceptable.
- E. Prepare test and inspection reports.

3.14 CLEANING

- A. Clean dirt and debris from fire-suppression system piping, system control valves, sprinklers, and associated components.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.15 DEMONSTRATION

- A. **[Engage a factory-authorized service representative to train] [Train]** Owner's maintenance personnel to adjust, operate, and maintain **[system control valves] [and] [pressure-maintenance pumps]**.

3.16 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with **[threaded ends, cast-iron threaded fittings, and threaded]** **[grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved]** joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
- D. CPVC pipe, **[Schedule 40] [Schedule 80]** CPVC fittings, and solvent-cemented joints may be used for light-hazard and residential occupancies.
- E. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2 (DN 50) and Smaller, to Be One of the Following:
 - 1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 3. Schedule 40, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 - 4. Schedule 40, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
 - 5. Schedule 40, black-steel pipe with **[cut-] [or] [roll-]**grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 6. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

7. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 8. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 9. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 10. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with plain ends; welding fittings; and welded joints.
 11. **[Schedule 40] [or] [Schedule 10S]** steel pipe; steel pressure-seal fittings; and pressure-sealed joints.
 12. **[Type L (Type B)] [Type M (Type C)]**, hard copper tube with plain ends; **[cast-] [or] [wrought-]**copper, solder-joint fittings; and brazed joints.
 13. **[Type L (Type B)] [Type M (Type C)]**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
 14. NPS 2 (DN 50), **[Type L (Type B)] [Type M (Type C)]**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
- F. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), to Be One of the Following:
1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 3. Schedule 40, black-steel pipe with **[cut-] [or] [roll-]**grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 4. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 5. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 6. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 7. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with plain ends; welding fittings; and welded joints.
 8. **[Type L (Type B)] [Type M (Type C)]**, hard copper tube with plain ends; **[cast-] [or] [wrought-]**copper, solder-joint fittings; and brazed joints.
 9. **[Type L (Type B)] [Type M (Type C)]**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
 10. **[Type L (Type B)] [Type M (Type C)]**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
- G. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 5 (DN 125) and Larger, to Be One of the Following:
1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 3. Schedule 40, black-steel pipe with **[cut-] [or] [roll-]**grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

4. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with plain ends; welding fittings; and welded joints.
8. **[Type L (Type B)] [Type M (Type C)]**, hard copper tube with plain ends; **[cast-] [or] [wrought-]**copper, solder-joint fittings; and brazed joints.
9. **[Type L (Type B)] [Type M (Type C)]**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

H. High-Pressure, Wet-Pipe Sprinkler System, NPS 4 (DN 100) and Smaller, to Be One of the Following:

1. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with plain ends; welding fittings; and welded joints.

I. High-Pressure, Wet-Pipe Sprinkler System, NPS 5 (DN 125) and Larger, to Be One of the Following:

1. Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
2. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. **[Schedule 10] [or] [engineered light-wall]**, steel pipe with plain ends; welding fittings; and welded joints.

3.17 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: **[Upright sprinklers] <Insert type>**.
2. Rooms with Suspended Ceilings: **[Pendent sprinklers] [Recessed sprinklers] [Flat concealed sprinklers] [Vertical sidewall sprinklers] [Pendent, recessed, flat concealed, vertical sidewall sprinklers as indicated]**.
3. Wall Mounting: **[Horizontal sidewall sprinklers] [Flat concealed sidewall sprinklers] [Horizontal sidewall, flat concealed sidewall sprinklers as indicated]**.
4. Spaces Subject to Freezing: **[Upright sprinklers] [Dry pendent sprinklers] [Dry sidewall sprinklers] [Upright sprinklers, dry pendent sprinklers, and dry sidewall sprinklers as indicated]**.
5. Deluge-Sprinkler Systems: **[Upright] [and] [pendent]**, open sprinklers.

6. Special Applications: **[Extended-coverage, flow-control, and quick-response sprinklers where indicated]** **[Attic sprinklers]** **[Combustible concealed space sprinklers]** **[Institutional space sprinklers]** <Insert type>.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces and locations not generally exposed to view; and wax coated where exposed to acids, chemicals, or other corrosive fumes.
 2. Recessed Sprinklers: Bright chrome, with **[bright chrome]** **[factory-painted white]** escutcheon.
 3. Flat Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 4. Residential Sprinklers: Dull chrome.

END OF SECTION 211000

SECTION 211313 - SPRINKLER AND STANDPIPE SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- a) Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- b) The following sections apply to the work of this section:
 - 1) 078413 Penetration Firestopping
 - 2) 238111 Fire Detection and Alarm Systems
 - 3) 211000 Fire Protection General Requirements

1.2 DEFINITIONS

- a) AHJ: Authority Having Jurisdiction: Any reference in the specifications or applicable codes to the AHJ shall be interpreted to mean City of Camden and the Department of Community Affairs (DCA).
- b) FM: FM Global (Factory Mutual)
- c) FPE: Fire Protection Engineer
- d) Furnish: To supply the stated equipment or materials
- e) Install: To set in position and connect or adjust for use
- f) NFPA: National Fire Protection Association
- g) NICET: National Institute for Certification in Engineering Technologies
- h) Provide: To furnish and install the stated equipment or materials
- i) UL: Underwriters Laboratories

1.3 SYSTEM DESCRIPTION:

- a) The design shall conform to NFPA 13 and the requirements specified herein. The design, equipment, materials, installation, workmanship, examination, inspection and testing shall be in strict accordance with NFPA 13, except as modified herein.
- b) Sprinkler system design basis requirements are provided on the drawings and shall be aligned with the smoke barriers as indicated.
 - 1) All health care areas, including offices, corridors, conference rooms: FM Global FMDS 0326 HC-1 Hazard Category, 0.10 gpm/ sq ft over 1500 sq ft.

- 2) All mechanical and electrical equipment areas: FM Global FMDS 0326 HC-2 Hazard Category, 0.20 gpm/ sq ft over 2500 sq ft.
- 3) All storage rooms and other hazardous spaces: FM Global FMDS 0326 HC-2 Hazard Category, 0.20 gpm/ sq ft over 2500 sq ft.
- c) Design and provide each system giving full consideration to blind spaces, piping, electrical equipment, duct work and other construction and equipment in accordance with detailed drawings to be submitted for approval.
- d) Equipment for fire protection service shall be UL listed or FM approved for use in wet pipe sprinkler systems.
- e) In the NFPA publications referred to herein, the advisory provisions shall be considered mandatory, as though the word "shall" had been substituted for "should," wherever it appears.

1.4 PERFORMANCE REQUIREMENTS

- a) Water Distribution: Distribution shall be uniform throughout the area which it is assumed the sprinkler heads will open. Variation in discharge from individual heads in the hydraulically most remote area shall be between 100 and 120 percent of the specified density.
- b) Piping Restrictions: Piping is prohibited in the following areas, except when solely supplying sprinklers in such areas:
 - 1) Electrical rooms and electrical closets.
 - 2) Telephone rooms and telephone closets.
 - 3) Elevator machine rooms and elevator shafts.
 - 4) Computer rooms.
- c) Clearance from Electrical Equipment: Piping and automatic sprinklers are prohibited directly over:
 - 1) Transformers.
 - 2) Substations.
 - 3) Switchboards.
 - 4) Motor control centers.
 - 5) Emergency generators.
 - 6) Bus Ducts.
 - 7) Electrical panels.

- d) If installing pipe over electrical equipment is unavoidable, maintain required dedicated space as defined by NFPA 70 and provide drip pans under piping to protect electrical equipment.
- e) Location of Sprinkler Heads: Heads in relation to the ceiling and the spacing of sprinkler heads shall not exceed their listed area of coverage for the hazard. Uniformly space sprinklers on the branch piping. Locate sprinkler heads in a consistent pattern with ceiling grid, lights, and supply air diffusers. Contractor is responsible for the final sprinkler head layouts and quantities.
- f) Sprinkler Discharge Area: The sprinkler discharge area shall be the hydraulically most remote areas as defined in NFPA 13. Remote area reductions permitted per NFPA 13 shall not apply.
- g) Hose Allowances: System design shall include an allowance of 250 gpm for total combined inside and outside hose streams.
- h) Hydraulic Calculations: Hydraulic calculations shall be in conformance with NFPA 13 and the following requirements:
 - 1) Margin of Safety: The sprinkler system shall be hydraulically designed so that the total waterflow and pressure demand is at least 10 psi less than the available water flow and pressure at the pump discharge.
 - 2) Friction Losses: Calculate losses in piping in accordance with the Hazen-Williams formula with "C" value of 100 for unlined ductile iron piping, 120 for steel piping, 130 for copper tubing.
 - 3) Flow Velocity: Piping shall be sized so that the water flow velocity does not exceed 40 ft/sec at any point in the system during maximum water flow (including inside hose demand). Flow velocity in each pipe segment is to be provided in the calculations.
 - 4) Test Point: Calculations shall be brought back to the existing fire pump discharge.
 - 5) Area of Coverage and Density: The area of coverage and density for each sprinkler shall be provided in the calculations.
 - 6) Equivalent Lengths: The equivalent lengths for all types of fitting and valve used shall be provided.
 - 7) Supply and Demand Graph(s): A graph comparing the water supply and the sprinkler and hose stream demand for each remote area shall be provided. Pressure and flow values for the supply and demand curves are to be provided on N^{1.85} graph paper.

1.5 SUBMITTALS

- a) Partial submittals will not be acceptable. Any installation work performed prior to the approval of the submittal shall be at the Contractor's own risk.
- b) Before any work is commenced, submit manufacturer's data (with listing or approval), system calculations, water supply data, and complete sets of working drawings.
- c) The Fire Protection Engineer shall review and approve submittals.
- d) Manufacturers' Data: Annotate descriptive data to show the specific model, type and size of each item the Contractor proposes to furnish. Include data for proper installation of each system including:
 - 1) Pipe, couplings, and fittings
 - 2) Valves
 - 3) Sprinkler heads
 - 4) Pipe hangers and supports
 - 5) Lubricating compound.
 - 6) Signs
 - 7) Caps, chains
 - 8) Drip pans
 - 9) Dielectric couplings
- e) Shop Drawings: Prepare working drawings on sheets not smaller than 24 in by 36 in (610 mm by 914 mm), in accordance with the requirements for "Working Plans" as specified in NFPA 13. A scaled site plan, with the location and elevation of the water flow test, shall be provided on the drawings.
- f) As-Built (Record) Working Drawings: On a weekly basis, the Contractor Superintendent, in conjunction with the Owner, shall review and record as-built conditions on a set of drawings maintained at the job site. After completion, but before final acceptance of the work, furnish a complete set of as-built drawings for review and approval by the Fire Protection Engineer. Make all necessary corrections to the drawings and furnish four sets of as-built drawings for record purposes. All deviations from the approved shop drawings shall be highlighted on the as-built drawings; if required by the Fire Protection Engineer the Contractor shall also provide hydraulic calculations justifying deviations. The drawings shall not be smaller than 24 in by 36 in. Provide 1 compact disc containing CAD based drawings in DXF and PDF based format of all as-built drawings and schematics.

- g) Operation And Maintenance Manuals: Furnish four (4) instruction manuals containing complete operation and maintenance instructions for the specific make and model of all check valves, detector check valves, alarm valves, waterflow and tamper switches, backflow preventers, and other trim furnished. Serial numbers and ordering information shall be provided. Place one copy of each instruction manual in a flexible, oil-resistant protective binder and mount in an accessible location in the vicinity of each alarm control valve. Furnish three additional copies of each instruction manual.

1.6 QUALITY ASSURANCE

- a) The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. All publications listed below refer to the most current edition.
- b) Manufacturers Qualifications
 - 1) American Society for Testing and Materials (ASTM) Publications:
 - 1) A53 Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless
 - 2) A135 Welded and Seamless Steel Pipe
 - 2) Factory Mutual System (FM) Publications
 - 1) Approval Guide
 - 3) National Fire Protection Association (NFPA) Publications – edition as referenced by NFPA 101 and the IBC
 - 1) 13 Installation of Sprinkler Systems
 - 2) 70 National Electrical Code
 - 3) 72 National Fire Alarm Code
 - 4) 101 Life Safety Code, 2012 Edition
 - 4) International Code Council (ICC)
 - 1) International Building Code, 2015 Edition
 - 5) Underwriters Laboratories, Inc. (UL) Publications:
 - 1) Fire Protection Equipment Directory
- c) Qualifications Of Installer:
 - 1) Prior to installation, submit data for approval by the FPE, showing that the Contractor has successfully installed automatic, wet pipe, fire extinguishing

sprinkler systems of at least 200 sprinkler heads each, or there is a firm contractual agreement with a subcontractor having such required experience. These systems shall be the same type and design which have been retrofitted into existing hospitals. The data shall include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. The Contractor shall indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months.

- 2) Design (including hydraulic calculations) shall be by a NICET Level III or IV Technician (in automatic sprinkler system design) or a Professional Engineer (P.E.), licensed in Fire Protection Engineering. Qualifications of the designer must be submitted to the FPE for approval.
- d) Service Organization: The Contractor shall furnish, to the Owner, evidence that there is an experienced and effective service organization which carries a stock of repair parts for the system in order to readily effect repairs throughout the warranty period. Should the Contractor fail to comply with the service requirements of this section, the Government will then have the option to make the necessary repairs and back charge the Contractor without any loss of warranty or guarantee as provided by the contract documents.

1.7 DELIVERY STORAGE AND HANDLING

- a) Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.
- b) Store materials inside, under cover, above ground, and kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.
- c) Automatic sprinklers must be kept in original packaging until they are installed. Loose carrying or storage is not permitted. Loose sprinklers shall be discarded immediately and replaced at Contractor's expense.

1.8 COORDINATION

- a) Coordinate sprinkler head layout with reflected ceiling plan and all ceiling – mounted equipment, including diffusers, lights, security cameras, fire alarm devices, exit signs, and other devices.
- b) Coordinate major equipment and piping layouts with other trades to avoid obstructions and excessive changes in direction for piping.

1.9 WARRANTY

- a) The Contractor shall guarantee labor, materials, and equipment provided under this contract against defects for a period of one year after the date of final acceptance of this work by the Government.

- b) Final acceptance includes, but is not limited to, the receipt and the FPE approval of, as-built drawings and operation and maintenance manuals.

1.10 EXTRA MATERIALS

- a) Provide spare sprinkler heads and wrenches per the requirements of NFPA 13.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- a) All products are subject to the following listed acceptable manufacturers. If the product is not addressed herein the product shall be from a US based manufacturer and listed for fire protection use.
- b) All products shall be FM approved/ UL listed.
- c) Fire Protection Valves and Drain Assemblies
 - 1) Tyco Fire & Building Products
 - 2) Victaulic
 - 3) Stockham
 - 4) Kennedy
 - 5) Jenkins
 - 6) Reliable Automatic Sprinkler Co.
 - 7) Viking Corporation
- d) Sprinklers
 - 1) Tyco Fire & Building Products
 - 2) Reliable Automatic Sprinkler Co.
 - 3) Viking Corporation
 - 4) Victaulic Corporation

2.2 ABOVEGROUND PIPING SYSTEMS

- a) Provide fittings for changes in direction of piping and for all connections. Arrange piping so that it can be drained at the main riser. Make changes in piping sizes through

standard tapered, reducing pipe fittings; the use of bushings will not be permitted. Perform welding in the shop; field welding will not be permitted.

- b) Jointing compound for pipe threads shall be polytetrafluoroethylene (PTFE) pipe thread tape and anaerobic pipe dope.
- c) Lubricant used on gaskets for mechanical fittings must be non-petroleum based and approved by the FPE.
- d) Run piping concealed in areas with suspended ceilings, except as noted on the drawings.
- e) Sprinkler Pipe and Fittings: Provide in accordance with NFPA 13, except as modified herein. Steel piping shall be Schedule 40 per ASTM A53 for sizes less than 4 inches (101.6 mm) and Schedule 10 or 40 per ASTM A53 for sizes 4 inches (101.6 mm) and larger. ASTM A135, Schedule 40 piping may be used for pipe sizes less than 2 ½ inches (63.5 mm).
 - 1) Standard Installation:
 - 1) Nominal pipe sizes 4 inches or larger: Schedule 10 or 40 Pipe meeting ASTM A-53, A-135 or A-795 with factory- or field-formed, roll-grooved for Schedule 10 or 40 ends, or cut-grooved for Schedule 40 ends.
 - 2) For connections between 4 inch and larger pipes the requirements are as follows.
 - 1) Grooved pipe couplings and fittings for grooved pipe.
 - 2) Outlet coupling with screwed connection for grooved pipe.
 - 3) For connection between 4 inch and larger pipes to pipes smaller than 4 inches the requirement is as follows.
 - 1) Welded outlet with screwed connection or threaded coupling or fittings.
 - 4) Nominal pipe sizes smaller than 4-inches: Schedule 40 Pipe meeting ASTM A-53, A-135, and A-795 with factory- or field-formed threaded ends:
 - 5) For connections to and between pipes less than 4 inches the requirement is as follows.
 - 1) Threaded pipe couplings and fittings only.
 - f) Pressure ratings: Pressure ratings of all fittings and gaskets shall meet or exceed maximum working pressures available within the system.
 - g) Corrosion protection: All piping and hangers where exposed to the weather or installed in a corrosive atmosphere shall be protected against corrosion by painting or special coatings.

- h) Pipe and Hanger Supports: Provide pipe supports, hangers, and clamps conforming to NFPA 13 and listed by UL or approved by FM. Provide galvanized supports, hangers, and clamps for all galvanized piping.
- i) Joint Construction
 - 6) Branch outlet mechanical fittings and clamp type fittings are not permitted.
 - 7) Procedures for welding outlets shall be in strict conformance with the welding requirements of NFPA 13, including submission of welding certifications. Welding shall not be performed on site.
 - 8) Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe with wall thickness less than Schedule 40.
 - 9) Grooved Joints and Fittings: Assemble joints and fittings with listed coupling and gasket, lubricant, and bolts from same manufacturer. Fittings and attached couplings shall be from the same manufacturer.
 - 10) Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
- j) Rubber-gasketed, grooved-end pipe and fittings with mechanical couplings shall only be permitted in pipe sizes 4 inches (101.6 mm) and larger.
- k) Restriction orifices, reducing flanges, unions, plain-end fittings, and segmented fittings are not permitted and shall not be used.
- l) The corrosion resistance ratio of pipe and fitting method shall not be less than 1.0.
- m) Pipe Hangers and Supports: Provide in accordance with NFPA 13. Powder-driven anchors shall not be used.
- n) Identification Signs: Attach properly lettered approved metal or polycarbonate signs conforming to NFPA 13 to each valve and alarm device. Polycarbonate signs shall be red with engraved white letters. Signs at valves shall describe the sprinkler zone it controls and state that the valve is to remain open. Permanently affix design data nameplate to the riser of each system.
- o) Pipe Sleeves and Seals. Provide where conduit or piping passes through walls, floors, roofs and partitions. Provide clearance between exterior of piping and interior of sleeve in accordance with NFPA 13. See Section 078413 Penetration Firestopping, for sleeves and seals through fire-rated assemblies. Secure sleeves in proper position and location during construction. Provide sleeves of sufficient length to pass through the entire thickness of walls, floors, roofs, and partitions.

- 1) Sleeves in Masonry and Concrete Walls, Floors, and Roofs: Provide ASTM A53, Schedule 40, zinc-coated steel pipe sleeves. Sleeves in floors shall project 4 inches (101.6 mm) above finished floors to prevent seepage.
- 2) Sleeves in Partitions and Other than Masonry and Concrete Walls, Floors and Roofs: Sleeves shall be constructed from either zinc-coated schedule 40 steel pipe or zinc-coated 26 gauge steel sheet.
- p) Escutcheon Plates: Provide one piece or split-hinge-type metal plates for piping passing through floor, walls, and ceilings in exposed and concealed areas. Provide chromium-plated or color-coordinated metal plates where pipe passes through finished ceilings. Securely anchor plates in proper position. Provide sprinkler escutcheon plates to match sprinkler head finish.

2.3 SPRINKLER HEADS

- j) Provide quick response sprinklers in offices and all other areas where their use is listed or approved. Heads located within the air streams of unit heaters or other heat-emitting equipment or skylights shall be selected for proper temperature rating.
- k) Sprinkler heads shall have a nominal ½ inch (12.7 mm) orifice.
- l) Corrosion-resistant sprinkler heads shall be installed where they are exposed to the weather, moisture or corrosive vapors.
- m) Sprinkler heads installed where they might receive mechanical injury or are less than 7 feet (2.13 m) above the floor level, shall be protected with approved guards in accordance with NFPA 13.
- n) Provide recessed sprinkler heads with chrome finish and chrome escutcheon as indicated on plans.
- o) Provide concealed sprinkler heads with white cover plates or other finish as indicated on plans.

2.4 VALVES:

- j) Provide valves as required by NFPA 13 and types UL listed or FM approved for fire protection service.
- k) Gate Valves: Gate valves shall be the outside stem & yoke (OS&Y) type, and open by counterclockwise rotation. Gate valves installed higher than 7 feet (2.13 m) above the floor shall be provided with a chain drive or permanently mounted ladder. Provide a gate valve beneath each alarm valve in each riser when more than one alarm valve is supplied from the same water supply pipe.
- l) Check Valves: Check valves shall be clear-opening, swing-check type, with a bronze or stainless steel seat ring and a EPDM rubber clapper facing. Flanged check valves of

sizes 4 inch (101.6 mm) and larger shall have flanged inspection and access cover plates.

- m) Butterfly valves: Butterfly valves are permitted only for pipe sizes of 4 inches (100 mm) and smaller.

2.5 DRY PIPE VALVE

- j) Dry pipe valves shall include all trimming as required for a standard unit, that are UL listed or FM approved. Provision shall be made to prevent excessive water accumulation. The dry pipe valve shall be fitted with an alarm bypass test connection so the waterflow device may be tested without opening the dry pipe valve.
- k) Each dry pipe valve shall be equipped with an automatic air maintenance device, in addition to all other required components.
- l) Provide an approved quick-opening device for dry pipe valves controlling systems having capacity of more than 500 gallons.

2.6 AUTOMATIC AIR COMPRESSOR

- j) The automatic air compressor shall have a tank capable of maintaining the required operating pressure on the dry system and capable of full recovery within 30 minutes. Provide all pressure switches, flow switches, supervisory switches and low/high air pressure switches in accordance with NFPA and the manufacturer's recommendations.
- k) The compressor shall be pad-mounted, with dryer, shall operate on 208 volt, 3 phase power and shall have a horsepower rating of 1½ or less. The starter shall be provided by the Fire Protection Contractor.

2.7 ALARMS

- j) Paddle-Type Water Flow Switches: Provide paddle-type water flow switches as indicated on the drawings. Switches shall have sensitivity setting to signal any flow of water that equals or exceeds the discharge from one sprinkler head. Water flow switch mechanisms shall incorporate an instantly recycling, pneumatic, adjustable retard element and shall be set with a 20-second delay. Assembly shall be rated at 175 psi (1206.6 kPa) cold water pressure. Switches shall be compatible with the fire alarm system and shall be connected per Section 283111.
- k) Pressure Switch: Provide switch with circuit opener and closer for automatic transmittal of an alarm over the facility fire alarm system and connect into the fire alarm system per Section 283111. Alarm actuating device shall be of the mechanical diaphragm, controlled water, pressure-type, without retard device, which instantly recycles when pressure is released from the diaphragm. Switches shall be compatible with the fire alarm system.

- l) Valve Supervisory Switch: Valve supervisory switches shall be installed on all sprinkler control valves. The switches shall be mounted so as not to interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than 1/5 of the distance from its normal open position. The mechanism shall be contained in a weather-proof, die-cast, aluminum housing that shall be provided with a 1/2 inch (12.7 mm) tapped conduit entrance and incorporate the necessary facilities for attachment to the valve. Switch housing shall be finished in red baked enamel. The entire installed assembly shall be tamper-proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting. Devices shall be compatible with and connected to the fire alarm system per Section 283111.

2.8 STANDPIPE VALVES

- j) General: Provide polished brass hose valves that are gate or angle type with screw-in bonnets, and 2-1/2 inch threaded male outlets with 1-1/2 inch adapters. Brass caps and chains are to be provided for each outlet.
- k) Valves and adapters are to have local fire department threads.

PART 3 - EXECUTION

3.2 INSTALLATION

- j) Equipment, materials, installation, workmanship, examination, inspection and testing shall be in accordance with NFPA 13, except as modified herein. Install piping straight and true to bear evenly on hangers and supports. Install piping as close to the ceiling as possible, without interfering with other equipment and construction. Nipples shall be perpendicular to ceilings.
- k) Accurately align sprinkler heads in suspended ceilings symmetrically with diffusers, lights, and ceiling tiles. Install sprinkler heads in the center of the ceiling tiles unless directed otherwise.
- l) Keep the interior and ends of all piping affected by Contractor's operations thoroughly clean of water and foreign matter by means of plugs or other approved methods. Inspect piping before placing into position. All pipe, fittings, and gaskets are to be cleaned of oil prior to installation.
- m) Installation shall be accomplished by the licensed contractor. Provide a qualified technician, experienced in the installation and operation of the type of system being installed, to supervise the installation and testing of the system.
- n) Installation of Piping: Accurately cut pipe to measurements established by the installer and work into place without springing or forcing. Install concealed piping in spaces that have finished ceilings. Where ceiling mounted equipment exists, such as in operating and radiology rooms, install sprinklers so as not to obstruct the movement or operation of the equipment. Sidewall heads may need to be utilized. Locate piping in

stairways as near to the ceiling as possible to prevent tampering by unauthorized personnel, and to provide a minimum headroom clearance of 2250 mm (seven feet six inches). To prevent an obstruction to egress, provide piping clearances in accordance with NFPA 101.

- o) Welding: Conform to the requirements and recommendations of NFPA 13.
- p) Drains: Pipe drains to discharge at safe points outside of the building or to sight cones attached to drains of adequate size to readily carry the full flow from each drain under maximum pressure. Do not provide a direct drain connection to sewer system or discharge into sinks. Install drips and drains where necessary and required by NFPA 13.
- q) Supervisory Switches: Provide supervisory switches for sprinkler control valves.
- r) Waterflow Alarm Switches: Install waterflow switch and adjacent valves in easily accessible locations.
- s) Inspector's Test Connection: Install and supply in conformance with NFPA 13, locate in a secured area, and discharge to the exterior of the building.
- t) Affix cutout disks, which are created by cutting holes in the walls of pipe for flow switches and non-threaded pipe connections to the respective waterflow switch or pipe connection near to the pipe from where they were cut.
- u) Sleeves: Provide for pipes passing through masonry or concrete. Provide space between the pipe and the sleeve in accordance with NFPA 13. Seal this space with a UL Listed through penetration fire stop material in accordance with Section 07 84 00, FIRESTOPPING. Where core drilling is used in lieu of sleeves, also seal space. Seal penetrations of walls, floors and ceilings of other types of construction, in accordance with Section 07 84 00, FIRESTOPPING.
- v) Provide pressure gauge at each water flow alarm switch location and at each main drain connection.
- w) Firestopping shall comply with Section 07 84 00, FIRESTOPPING.
- x) Securely attach identification signs to control valves, drain valves, and test valves. Locate hydraulic placard information signs at each sectional control valve where there is a zone water flow switch.
- y) Repairs: Repair damage to the building or equipment resulting from the installation of the sprinkler system by the installer at no additional expense to the Government.

3.3 FIELD CHANGES

- j) Do not make field changes in the piping layout, pipe sizes, or type of equipment, without the prior approval of the Owner.

3.4 CONNECTIONS TO EXISTING SPRINKLER SYSTEM

- j) Connection to the existing sprinkler system shall be done only after successfully testing new piping. Connections shall be as shown on the drawings. The Owner shall be notified at least 4 days prior to interruption of sprinkler protection.
- k) A schedule of any interruption of service shall be provided to the Owner and approval received before any service is interrupted. In no case shall the existing sprinkler system be shut off during periods other than normal Contractor construction hours.
- l) There shall be no interruption of the existing sprinkler protection, water, electric, or fire alarm services without prior permission of the Owner. Contractor shall develop an interim fire protection program where interruptions involve in occupied spaces. Request in writing at least one week prior to the planned interruption.

3.5 FIELD PAINTING

- j) Painting shall be per Section 099000, Painting, except as modified herein. The above-ground steel piping systems including valves, piping [in finished areas], pipe sleeves, conduit, hangers, miscellaneous metal work and accessories shall be cleaned, pre-treated, primed and painted. Coatings shall be applied only to clean, dry surfaces using clean brushes. Surfaces shall be cleaned to remove all dust, dirt, rust and loose mill scale.
- k) Immediately after cleaning, provide the metal surfaces with one coat of primer, applied to a minimum dry film thickness of 1.0 to 1.5 mil. Due care shall be exercised to avoid the painting of sprinkler heads or protective devices or allowing paint to drip or splatter on any equipment, artifacts, building structures, and floors. Materials which are used to protect sprinkler heads while painting is in progress shall be removed upon completion of painting.

3.6 FIELD TESTING AND FLUSHING

- j) All testing shall be scheduled with the Owner.
- k) Hydrostatic tests shall be conducted at 200 psi (1379 kPa) for a 2 hour period with no leakage or reduction in gage pressure. Hydrostatic test pressures shall not be maintained on the system overnight. Flush piping with potable water in accordance with NFPA 13.
- l) Preliminary Tests and Procedures: Test the alarms and other devices. Test the water flow alarms by flowing water through the inspector's test connection. When all tests and procedures are completed and corrections made, submit a signed and dated certificate, similar to that specified in NFPA 13, with a request for formal inspection and tests.

- m) Formal Inspection and Tests: At this time, all piping sprinklers, and other system components shall be in-place and all adjustments to the system completed. Submit a request for a formal inspection at least five working days prior to the date the inspection is to take place. A competent representative of the sprinkler installer shall be present during testing and inspection. As-built drawings shall be on-site for the inspection. At this inspection, the system shall be hydrostatically tested. Any or all of the required tests shall be conducted by the Contractor at his own expense and additional tests made until it has been demonstrated that the systems comply with all contract requirements. The Contractor shall furnish all appliances, equipment, instruments, connecting devices and personnel for the tests. Any costs incurred by the Owner for repeat tests, due to the failure of the Contractor to adequately demonstrate that the system complies with the contract requirements, shall be borne by the Contractor.
- n) CONNECTIONS TO EXISTING PIPING: During air and hydrostatic testing, the Contractor shall test new piping prior to connecting to the existing system. If the Contractor chooses to test the new piping while it is connected to existing piping or valves, the Contractor shall assume responsibility for all piping and equipment which is pressurized, as well as any damage caused by the failure of existing or new sprinkler systems. The Owner accepts no responsibility for existing valves' performance to withstand hydrostatic pressure testing.

END OF SECTION 211313

SECTION 220100 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Adventist Health Preferred Partner List: All major vendors, manufacturers and equipment must be on the Adventist Preferred Partner List. All pricing shall be obtained from specific contact indicated on Adventist preferred partner list. In the event a facility standard product is not on the preferred partner list, permission must be obtained through Adventist Health System. Adventist preferred partner list shall overrule any manufacturers that may be listed in this written specification.
- B. Basic Requirements: Requirements of the Contract Forms, Conditions of the Contract, Specifications, Drawings, and Addenda and Contract Modifications (the Contract Documents), apply to the requirements of each Section of Division 22.
- C. Conflicts: Nothing contained in this Section shall be construed to conflict in any way with other provisions or requirements of the Contract documents. The intent is that this Section will take precedence. Where differences arise, the Architect shall decide which directions or instructions take precedence.

1.2 SUMMARY

- A. General: Unless an item is specifically mentioned as being provided by others, the requirements of Division 22 Contract Documents shall be completed. The systems, equipment, devices and accessories shall be installed, finished, tested and adjusted for continuous and proper operation. Any apparatus, material or device not shown on the Drawings but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the project complete and operational in all respects, shall be furnished, delivered and installed without additional expense to the Owner. Include all materials, equipment, supervision, operation, methods and labor for the fabrication, installation, start-up and tests necessary for complete and properly functioning systems.

1.3 APPLICABLE STANDARDS

- A. Code Compliance: Refer to Division 1. As a minimum, unless otherwise indicated, comply with all rules, regulations, standards, codes, ordinances and laws of local, state and federal governments and the amendments and interpretation of such rules, regulations, standards, codes, ordinances and laws of local, state and federal governments by the authorities having lawful jurisdiction.
- B. ADA: Comply with the requirements of the Americans with Disabilities Act (ADA).
- C. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.
- D. State of Maryland – Fire prevention Code (Codes adopted as of April 1, 2021)
 - 1. 2018 NFPA 1 Fire Code

2. 2018 NFPA 101 Life Safety Code
 3. 2016 NFPA 13, 13R, 13D Fire Sprinkler Codes
 4. 2016 NFPA 72 Fire Alarm Code
 5. 2018 City of Rockville Chapter 9 Local Amendments
- E. Montgomery County Maryland
1. <https://www.montgomerycountymd.gov/mcg/countycode.html>
 2. https://codelibrary.amlegal.com/codes/montgomerycounty/latest/montgomeryco_md/0-0-0-2
 3. Code Amendments, IBC
- F. City of Rockville Maryland:
- <https://www.rockvillemd.gov/2169/Building-and-Safety-Codes>
https://library.municode.com/md/rockville/codes/code_of_ordinances
1. 2018 International Building Code (IBC)
 2. **2018 International Plumbing Code (IPC)**
 3. 2018 International Mechanical Code (IMC)
 4. 2018 International Fuel Gas Code (IFGC)
 5. 2018 International Energy Conservation Code (IECC)
 6. 2018 International Existing Building Code (IEBC)
 7. 2017 National Electrical Code (NFPA 70)
 8. 2015 International Green Construction Code (IgCC)
 9. 2010 ADA Standards
 10. City of Rockville Amendments
 11. Maryland Fire Prevention Code,
<https://mdsp.maryland.gov/firemarshal/Documents/State%20Fire%20Prevention%20Code%202016%20January%20001%20Adopted.pdf>
- G. FGI Guidelines for Design and Construction of Healthcare Facilities, 2018 Edition
1. ASHRAE Standard 170, 2017 Edition
- H. NATIONAL FIRE PROTECTION (NFPA) Standards:
1. NFPA 1 – Uniform Fire Code, 2018 Edition
 2. NFPA-10, Standard for Portable Fire Extinguishers, 2013 Edition
 3. NFPA-30, Flammable and Combustible Liquids Code, 2015 Edition
 4. NFPA-45, Standard on Fire Protection for Laboratories Using Chemicals, 2011 Edition
 5. NFPA-51B, Standard for Fire Prevention During Welding, Cutting, other Hot Work, 2014 Edition
 6. NFPA-70, National Electrical Code, 2017 Edition
 7. NFPA-72, National Fire Alarm Code, 2016 Edition
 8. NFPA-99, Standard for Health Care Facilities, 2018 Edition
 9. NFPA-101, Life Safety, 2018 Edition
- I. NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
1. All potable water distribution system components shall be Lead-Free.

- J. Notification: Comply with all of the requirements of the Federal "Right-To-Know" Regulations and provide notification to all parties concerned as to the use of toxic substances.

1.4 DRAWINGS AND SPECIFICATIONS

- A. Intent: The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
- B. Equipment Placement: The drawings are diagrammatic, intended to show general arrangement, capacity and location of various components, equipment and devices. Each location shall be determined by reference to the general building plans and by actual measurements in the building as built. Reasonable changes in locations ordered by the Architect prior to the performance of the affected Work shall be provided at no additional cost to the Owner.
- C. Drawing Scale: Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets, transitions and fittings may not be shown but shall be provided at no additional cost.
- D. Conflict: In the event of a conflict, the Architect will render an interpretation in accordance with the General Conditions.

1.5 DEFINITIONS

- A. Provide/Install: The word "provide" shall mean furnish, install, connect, test, complete, and leave ready for operation. The word "install" where used in conjunction with equipment furnished by the Owner or under another contract shall mean mount, connect, complete, and leave ready for operation.
- B. Concealed: The surface of insulated or non-insulated piping, ductwork or equipment is concealed from view when standing inside a finished room, such as inside a chase or above a ceiling.
- C. Exposed: The surface of insulated or non-insulated piping, ductwork or equipment is seen from inside a finished room, such as inside an equipment or air handling unit room.
- D. Protected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building but protected from direct exposure to rain by an overhang, eave, in an unconditioned parking garage or building crawl space.
- E. Unprotected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building and exposed to rain.
- F. Abbreviations: Abbreviations, where not defined in the Contract Documents, shall be interpreted to mean the normal construction industry terminology, as determined by the Architect. Plural words shall be interpreted as singular and singular words

shall be interpreted as plural where applicable for context of the Contract Documents.

1.6 SHOP DRAWINGS

- A. General: Refer to paragraph entitled "SUBMITTAL" in this section. Include the following data:

1. Shop Drawings:

- a. Submit shop drawings for the following:

- (1) Each Piping System
- (2) Coordination Drawings

1.7 RECORD DRAWINGS

- A. Production: Maintain one set of red lined record "as-built" drawings at the site. Record drawings shall be updated weekly to record the present stage of progress. These drawings shall be available to the Architect at all times.
- B. Completion: Prior to substantial completion, transfer into electronic media, all changes, and submit them to the Architect. Upon completion of all punch lists, transfer all "As-Built" conditions to the AutoCAD drawing files, package three (3) print sets of full-size drawings and two (2) CDs of the AutoCAD drawing files with associated reference files and submit them to the Architect for review and approval.

1.8 SUBMITTAL

- A. General: The provisions of this section are supplemental to the requirements in Division 1, and only apply to the material and equipment covered in Division 23.
- B. Time: Submit manufacturer's literature, performance data and installation instructions covered in each Section of Division 23 under an individual letter of transmittal.
- C. Submitter's Review: All items required for each section shall be reviewed before submittal. Submittal information for each item shall bear a review stamp of approval, indicating the name of the Contractor and Subcontractor (where applicable), the material suppliers, the initials of submitter and date checked. Responsibility for errors or omissions in submittals shall not be relieved by the Architect's review of submittals. Responsibility for submittals cannot be subrogated to material suppliers by Contractors or Subcontractors.
1. Review of the submittal data, whether indicated with "APPROVED" or with review comments, does not constitute authorization for or acceptance of a change in the contract price.

- D. Architect's Review: The submittal data shall be reviewed only for general conformance with the design concept of the project and for general compliance with the Contract Documents. Any action indicated is subject to the requirements of the Contract Documents. Reviews of submittal data review shall not include quantities; dimensions (which shall be confirmed and correlated at the job site); fabrication processes; techniques of construction; and co-ordination of the submittal data with all other trades. Copies of the submittal data will be returned marked "ACCEPTED AS SUBMITTED", "ACCEPTED AS NOTED", "REVISED AS NOTED AND RESUBMIT", "REJECTED, REVISED AS NOTED AND RESUBMIT".
- E. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right-hand corner of each item.
1. Manufacturer's Literature: Where indicated, include the manufacturer's printed literature. Literature shall be clearly marked to indicate the item intended for use.
 2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.
 3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.
 4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of product, they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
 5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment, they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".

F. Substitutions:

1. General: Refer to Division 1. Substitutions may be considered for any product or equipment of a manufacturer. See paragraph entitled "MANUFACTURER" in this Section. Any product or equipment may be submitted for review
 - a. Submittal shall include the name of the material or equipment to be substituted, equipment model numbers, drawings, catalog cuts, performance and test data and any other data or information necessary for the Architect to determine that the equipment meets the specification requirements. If the Architect accepts any proposed substitutions, such acceptance will be set forth in writing.
 - b. Substituted equipment with all accessories installed or optional equipment where permitted and found acceptable, must conform to space requirements. Substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at no additional expense to the Owner. If the substituted item affects the work of other trades, the Request for Substitution form shall include a list of the necessary modifications.
2. Deviations: The Request for Substitution form shall include a complete list of deviations from the scheduled item stating both the features and functions of the scheduled item and the comparable features and functions of the proposed substitution.
 - a. Any deviation not indicated in writing will be assumed to be identical to the specified item even if it is shown otherwise on the submittal data.
 - b. The Architect shall retain the right to specify modifications to the substituted item, correcting or adjusting for the deviation, if the Architect deems it to be in the best interest of the Owner.
3. Scheduled Item: A scheduled item is a product or item of equipment indicated in the Contract Documents by manufacturer's name and model number identifying a single item. The manufacturer's trade name for a group of products that does not signify a single item including type, style, quality, performance, and sound rating shall not be classified as a scheduled item. Where more than one manufacturer and product model number are indicated, each shall be considered as a scheduled item.
4. Form: When a product or item of equipment is proposed as a substitution a "REQUEST FOR SUBSTITUTION" form shall be completed and submitted with the required data. A copy of the form is included after the end of this section.
5. Rejection: Substituted products or equipment will be rejected if, in the opinion of the Architect, the submittal does not meet any one of the following conditions or requirements:

- a. The submittal data is insufficient or not clearly identified. The Architect may or may not request additional information.
- b. The product or equipment will not fit the space available and still provide the manufacturers published service area requirements.
- c. The product or equipment submitted is not equivalent to or better than the specified item. Products or equipment of lesser quality may be considered provided an equitable financial rebate, satisfactory to the Architect, is to be returned to the Owner.
- d. The product or equipment submitted has less capacity, efficiency and safety provisions than the specified item.
- e. The product or equipment submitted does not have warranty, service and factory representation equivalent to that specified.
- f. The Owner prefers not to accept the submitted product.

G. Technical Information Brochure: Electronic Copy Format:

1. Format: All Technical Information Brochures are to be supplied in PDF formats as single electronic systems with suitable hyperlinks to all associated files and documents for easy retrieval and use by Architect/Owner. Document shall be separated into three sections: PLUMBING SUBMITTAL DATA, PLUMBING OPERATION INSTRUCTION AND PLUMBING MAINTENANCE INSTRUCTIONS.
2. Number: Submit not less than five copies of the electronic technical information brochures as noted above.

1.9 SHOP DRAWINGS FOR PIPING SYSTEMS

- A. Requirements: Make Shop Drawings for piping systems at a minimum scale of 1/4 inch per foot in AutoCAD Version. Show required maintenance and operational clearances. Number drawings sequentially and indicate:
 1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
 2. Fabrication and erection dimensions.
 3. Arrangements and sectional views, as required.
 4. Necessary details, including complete information for making connections to equipment, as required.
 5. Descriptive names of equipment that align to equipment schedule "tags".
- B. Stamp Area: Leave 4 inch by 2-1/2-inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and equipment connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Additional Requirements: See specific Sections for additional requirements.

1.10 COORDINATION DRAWINGS

- A. General: Provide detailed (minimum 1/4-inch per foot) scaled coordination drawings showing locations and positions of all architectural, structural, electrical, plumbing, fire protection and mechanical elements for all installations. Coordinate, prior to beginning work, indicating work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions and other services.
- B. Coordination of Space: Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

In finished areas except as otherwise shown, conceal pipes, ducts, and wiring in construction. Coordinate locations of fixtures and outlets with finish elements. Contractor shall provide background drawings showing partitions, ceiling heights, and structural framing locations and elevations, and existing obstructions. Contractor shall resolve major interferences at initial coordination meeting prior to production of coordination drawings.

- C. Precedence of Services: In event of conflicts and interferences involving location and layout of work, use the following priority to resolve interferences:
 - 1. Structure has highest priority.
 - 2. Walls systems.
 - 3. Ceiling grid/light fixtures.
 - 4. Gravity drainagelines.
 - 5. Large pipe mains.
 - 6. Ductwork/diffusers, registers and grilles.
 - 7. Sprinkler heads.
 - 8. Small piping and tubing/electrical conduit.
 - 9. Access panels.
- D. Drawings shall be developed on AutoCAD Version 2018 (or later) and utilize AIA Standard layering conventions. At the completion of the project construction, the Contractor shall provide two (2) full-sized print sets and two (2) CDs of all drawing files with related reference files representing as-built installations for Architect review. Upon approval that the submitted information is complete, a similar submittal shall be provided to the Owner.
- E. Additional Requirements: See specific Sections for additional requirements.

1.11 MANUFACTURER'S CHECKOUT

- A. Start-up and Checkout: At completion of installation and prior to performance verification, a factory-trained representative of the manufacturer shall provide start-up and checkout service. After the performance verification the manufacturer's representative shall examine performance information and check the equipment in operation, and sign "Check- Out Memo" for the record. Submit a copy of Memo on each item of equipment where indicated in individual sections of these specifications for inclusion in each Technical

Information Brochure. The "Check-Out Memo" shall be included with the performance verification data.

1.12 INSTRUCTION TO OWNER

- A. General: Instructions to the Owner shall be by competent representatives of the manufacturers involved, with time allowed for complete coverage of all operating procedures. Provide as required classroom instruction and field training in the design, operation and maintenance of the equipment and troubleshooting procedures. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar provisions of the systems. On the date of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.
- B. Training Period: Unless otherwise indicated training periods shall encompass the following number of hours of classroom and hands-on instructions with a maximum period of 4 hours per day for either. Mixing classroom instructions and hands on training in the same day is unacceptable.

1. Training Periods:

- a. 4 hours Classroom
- b. 4 hours Hands-on

- C. Scheduling: Submit any remaining required items for checking at least one week before final inspection of building. When submittal items are found acceptable, notify Owner, in writing that an "Instruction in Operation Conference" may proceed. Conference will be scheduled by the Owner. After the conference, copies of a memo certifying that the "Instruction in Operation Conference" and "Completed Demonstration" have been made will be signed by Owner and the instructors, and one copy will be included in each Technical Information Brochure.

1.13 ALLOWANCES

- A. General: Division 1.

1.14 ALTERNATES

- A. Refer to Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specified Products: Manufacturer's names and product model numbers indicated on the drawings and in these specifications establish the type, style, quality, performance, and sound rating of the desired product. Listing of other manufacturers indicates that their equivalent products would be acceptable if they meet the specification requirements, the specific use and installation shown on the drawings, including space and clearance requirements, and the energy consumption and efficiency of the specified product. The listing of additional manufacturers in no way indicates that the manufacturer can provide an acceptable product.
- B. Space Requirements: All manufactured products furnished on this project must have the required space and service areas indicated in the manufacturer's printed literature or shown on their shop drawing. When the manufacturer does not indicate the space required for servicing the equipment, the space shown on the drawings or as required by the Architect must be provided.

2.2 MATERIAL AND EQUIPMENT

- A. General: Material and equipment used shall be produced by manufacturers regularly engaged in the production of similar items, and with a history of satisfactory use as judged by the Architect.
- B. Specified Equipment: Equipment shall be the capacity and types indicated or shall be equivalent in the opinion of the Architect. Material and equipment furnished and installed shall be new, recently manufactured, of standard first grade quality and designed for the specific purpose. Equipment and material furnished shall be the manufacturer's standard item of production unless specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution. Ratings and capacities shall be certified by a recognized rating bureau. Products shall be complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.
- C. Compatibility: Material and equipment of one and the same kind, type or classification and used for identical or similar purposes shall be made by the same manufacturer. Where more than one choice is available, select the options which are compatible with other products already selected. Compatibility is a basic general requirement of product selection.
- D. Coordination of Materials: In the event of multiple award packages for the completion of this work, the Contractor shall direct and lead the coordination effort necessary to ensure that all materials and equipment that have moving parts, are procured from the

same manufacturer and are the same model as consistent with its use and as required by these specifications.

The Contractor shall additionally ensure that the installation of this material and equipment is consistent for the Owner's use and maintenance and shall affect necessary adjustments to render the installations consistent.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be done in a neat, workmanlike by of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a first-quality installation. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks. All materials and equipment shall be installed per the manufacturer's written requirements.
- B. Performance: Material and equipment installations not in compliance with the Contract Documents, shall be removed and reinstalled by qualified craftsmen at no change in the contract price.

3.2 CLEANING AND PROTECTION

- A. General: Refer to Division 1.
- B. Emergency Contacts: Prior to the beginning of the project, provide the Owner with a list of names, emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period if leaks, equipment failure or other damages occur. Update the list throughout installation and warranty to provide continuous availability of responsible parties to the Owner.
- C. Emergency Contacts: Along with the operating and maintenance manual submittal, provide the Owner with a list of the names and emergency telephone of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period should leaks, equipment failure or other damage occur. Update the list throughout warranty to provide continuous availability of responsible parties to the Owner.
- D. Housekeeping: Keep interiors of duct and pipe systems clean and free from dirt, rubbish and foreign matter. Close open ends of piping and ductwork at all times throughout the installation. Install 30% efficient filter media over each return air grille and open return duct opening; change media regularly during construction when dirty to keep duct interiors clean. Prevent dust, debris and foreign material from entering the piping and ductwork.
- E. Equipment Protection: Protect fan motors, switches, equipment, fixtures, and other items from dirt, rubbish and foreign matter.

- F. Equipment Cleaning: Thoroughly clean equipment and entire piping systems internally prior to final acceptance. Open dirt pockets and strainers, blow down each piping system and clean strainer screens of accumulated debris. Remove accumulated dirt, scale, oil and foreign substances. Thoroughly wipe clean internal surfaces of air handling units prior to request for substantial completion. (See para. 3.2 above.)
- G. Building Cleanup: Remove debris, rubbish, leftover materials, tools and equipment from work areas and site. Clean tunnels and closed off spaces of packing boxes, wood frame members and other waste materials used in the installation. Final acceptance shall not be approved until site is cleaned.
- H. Fixture Cleanup: Remove temporary labels, stickers, etc., from fixtures and equipment. Do not remove permanent nameplates, equipment model numbers, ratings, etc.
- I. Filter Replacement: Provide filters, with the same efficiency rating as required for the final installation, for the protection of the air moving equipment and ductwork continuously throughout the construction phase. Provide a new set of clean filters for the test and balance of the air side equipment.
- J. Protection of Finished Installation: Where installation is required in areas previously finished by other trades, protect the area from marring, soiling or other damage.

3.3 COORDINATION AND ASSISTANCE

- A. General: Provide all labor, equipment, tools and material required to operate the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.
- B. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the Commissioning Agent and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

3.4 PREPARATIONS FOR PERFORMANCE VERIFICATION

- A. Verification: Prior to commencement of the balancing by the Commissioning Agent, the Contractor shall verify in writing:
 - 1. That strainers have been removed, cleaned and replaced, and that temporary construction strainers have been removed.

2. That compression or expansion tanks have been inspected, are not air-bound or water-logged and are pre-charged, and that the piping systems have been completely vented and filled with water.
3. That air vents at high points of the piping systems have been inspected and installed and operating freely.
4. That automatic valves, hand valves, and balancing valves have been placed in a fixed open position for full flow through all devices.
5. That linkages between valves and their actuators are secure, non-overloading and non-binding.
6. That pressures for pressure reducing valves have been set.
7. That operating temperatures have been set for heat exchangers, regulating valves, etc.
8. That pumps are operating at the correct rotation and specified horsepower.
9. That piping has been pressure tested and accepted and piping systems have been cleaned, flushed, sterilized and refilled with chemicals and prescribed treated water and vented.
10. That operating temperatures have been set for boilers, regulating valves, etc.
11. That the operating safeties (thermal overloads, firestat/freezestats, smoke detectors, relief valves, etc.), are installed and fully functional.
12. That equipment has been lubricated and can be operated without damage.
13. That the systems are operational and complete.
14. That no latent residual work remains to be completed.

3.5 ACCEPTANCE TESTING PROCEDURE

- A. General: Each plumbing system shall be tested to confirm proper operation and function in accordance with the construction documents and sequence of operations.
- B. The enclosed checklists shall be completed for each system and signed off by the mechanical sub-contractor project representative, then verified and signed-off by the mechanical sub-contractor project supervisor and the construction manager systems engineer. All checklists shall be incorporated into the project's close-out manuals submitted for Owner record.
- C. On-site testing by the Architect and Engineer shall be performed at the discretion of the Architect/Engineer for any or all systems to confirm test results and system function.
- D. The Contractor is responsible to provide adequate time in the completion of the construction to perform these system tests prior to the AHCA final inspections in the affected areas/systems.
- E. The Contractor is responsible for ensuring all required system tests are conducted successfully and recording associated test data and results.
- F. The Contractor is responsible for contacting the Architect and Engineer at least two weeks prior to system test availability and schedule acceptable to Architect/Engineer for on-site testing.

- G. If, in the Architect's and Engineer's opinion, the test results indicate that the systems' installation is not adequately complete for testing, the testing shall be re-scheduled, and the Contractor shall be responsible to prepare for such re-test.
- H. Prior to Owner occupancy, all system testing shall be completed and approved.

3.6 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been "dried in". If dry space is unavailable and the insulation and equipment must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.
- B. Replacement of Damaged Stored Material and Equipment: Any material and equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be repaired per manufacturer's recommendations or replaced with new when repair is not feasible.
- C. During construction, all piping and ductwork system openings shall be provided with end protection using end caps, polyester tape, tubing inserts or PVC shrink film.
- D. All air diffusers serving critical care areas shall be disinfected per owner infection control guidelines.

3.7 COORDINATION OF SERVICES

- A. General: Where phasing of the work requires partial occupancy, coordinate interruption of services to Owner-occupied areas in writing in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.
- B. General: Coordinate interruption of services in writing at least 1 week in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.
- C. Protection of Facilities: Portions of the building may be operational during construction. Maintain operation of the equipment and systems whenever the installation interfaces with equipment or systems. Provide protection for the building, its contents and occupants wherever installation under the contract is performed. As necessary, move, store, and protect furniture, office fixtures and carpets. Provide acoustical isolation of the work area with temporary doors, partitions, etc., to allow normal work functions. Provide exhaust fans, temporary dust barrier partitions and any containment measures required to prevent dirt, dust or fumes from reaching adjacent occupied spaces as required by the Owner or Architect. Access to the building, including exit stairs, doors and passageways, and loading dock and other delivery areas shall be kept open and continuously accessible to the occupants. Workmen shall

be confined to those areas directly involved in the project installation, and only during time periods indicated and approved by the Owner.

3.8 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

END OF SECTION 220100

REQUEST FOR SUBSTITUTION

Project Name: _____ Location: _____

Date of Request: _____

Name of Party Requesting Substitute:

Reason for Substitution Request:

<u>Drawing</u>	<u>Spec. Sect. No.</u>	<u>Paragraph</u>	<u>Specified Item</u>	<u>Manu</u>	<u>Model</u>
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_____	_____	_____	_____	_____	_____
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Proposed Substitute: _____

Manufacturer and Model Number:

Deviations from the Specified Item: (See paragraph entitled "Deviations".)

Reason for Substitution:

Changes to Other Systems to Permit Use of Proposed Substitute:
(List changes. Submit drawings if required for clarity.)

Technical Data to Support Request for Acceptance:
(List ASTM or other standards designations, testing laboratory reports, experience records, etc.)

Other Supporting Data:
(Submit brochures, samples, drawings, etc.)

REQUEST FOR SUBSTITUTION(Continued)

Certification: In making request for substitution, the party whose authorized signature appears below, certifies that all of the following statements are correct and are accepted without exception:

The proposed substitution has been personally investigated and is equal or superior in all significant respects to the product specified for the specific applications required.

The proposed substitution will be warranted under the same terms required for the specified product;

Coordination aspects necessitated by the proposed substitution will be accomplished in a complete and proper fashion by the party signing this form without any additional cost to the Owner; and

Claims against the Owner for additional costs related to the proposed substitution which subsequently become apparent after acceptance by the Architect are hereby waived.

CERTIFICATION OF EQUIVALENT PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUIVALENT PERFORMANCE

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by: _____
Signature Title

Typed Name: _____

Company: _____

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 1. CPVC: Chlorinated polyvinyl chloride plastic.
 2. PE: Polyethylene plastic.
 3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

- C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Flux shall conform to ASTM B813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.

- b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
- 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

B. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.

- 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

- 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

- 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated and rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated and rough brass.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 3. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 4. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 2. Existing Piping: Use the following:
 - a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.

- b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.
 - 4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble

mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 220500

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.

- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 220517

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Test-plug kits.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of meter and gage, from manufacturer.
- C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Terrice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. Winters Instruments - U.S.
 - d. Or equal.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle unless otherwise indicated.
 - 5. Tube: Glass with magnifying lens and blue or red organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CUNI.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
6. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Trerice, H. O. Co.
 - b. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - c. Weiss Instruments, Inc.
 - d. Or equal.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated

- in psi and kPa.
- 8. Pointer: Dark-colored metal.
- 9. Window: Glass.
- 10. Ring: Metal.
- 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trerice, H. O. Co.
 - 2. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 3. Weiss Instruments, Inc.
 - 4. Or equal.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: EPDM self-sealing rubber.

2.6 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trerice, H. O. Co.
 - 2. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 3. Weiss Instruments, Inc.
 - 4. Or equal.
- B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

- C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- E. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install test plugs in piping tees.
- I. Install thermometers in the following locations:
 - 1. Outlet of each water heater.
 - 2. Outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
- J. Install pressure gages in the following locations:
 - 1. Inlet and outlet of each pressure-reducing valve.
 - 2. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service

and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
 - 1. Industrial-style, liquid-in-glass type.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
 - 1. Industrial-style, liquid-in-glass type.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.
- B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.
- B. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
 - 1. Liquid-filled, direct-mounted, metal case.
 - 2. Test plug with EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Water Piping: 0 to 150 psi.

END OF SECTION 220519

SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following general-duty valves:
 - 1. Copper-alloy ball valves.
 - 2. Ferrous-alloy ball valves.
 - 3. Bronze check valves.
 - 4. Gray-iron swing check valves.
 - 5. Spring-loaded, lift-disc check valves.
 - 6. Bronze gate valves.
 - 7. Cast-iron gate valves.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. PTFE: Polytetrafluoroethylene plastic.
 - 3. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

- A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- B. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and protect valves from damage from condensation. If outdoor storage is necessary, store valves off the ground and protect from water.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
- C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 1. Handwheel: For valves other than quarter turn types.
 2. Lever Handle: For quarter turn valves NPS 6 and smaller, except plug valves.
 3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug heads.
- G. Extended Valve Stems: On insulated valves.
- H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves and ASME B16.24 for bronze valves.
- I. Valve Grooved Ends: AWWA C606.
 1. Solder Joint: With sockets according to ASME B16.18.
 - a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
 2. Threaded: With threads according to ASME B1.20.1.

- J. Valve Bypass and Drain Connections: MSS SP-45.

2.3 COPPER-ALLOY BALL VALVES

A. Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:

- a. Apollo Valve
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Stockham Div.
- d. Hammond Valve.
- e. NIBCO INC.
- f. Milwaukee Valve Company
- g. Or equal.

B. Copper-Alloy Ball Valves, General: MSS SP-110.

- C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

D. Butterfly Valves

1. Ductile Iron Butterfly Valves- AWWA C-504, Flanged Lead Law Compliant 3 Ductile Iron Bronze or Stainless Disc. EPDM Lug Butterfly Valve Lever Operator.

2.4 BRONZE CHECK VALVES

A. Manufacturers:

1. Bronze, Horizontal Lift Check Valves with Nonmetallic Disc:

- a. Apollo Valve
- b. Cincinnati Valve Co.
- c. Crane Co.; Crane Valve Group; Crane Valves.
- d. Crane Co.; Crane Valve Group; Stockham Div.
- e. Or equal.

2. Bronze, Vertical Lift Check Valves and Metal Disc:

- a. Apollo Valve
- b. Cincinnati Valve Co.
- c. Crane Co.; Crane Valve Group; Crane Valves.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Or equal.

3. Bronze, Vertical Lift Check Valves with Nonmetallic Disc:

- a. Apollo Valve
 - b. Grinnell Corporation.
 - c. Kitz Corporation of America.
 - d. Milwaukee Valve Company.
 - e. Or equal.
4. Bronze, Swing Check Valves with Nonmetallic Disc:
- a. Apollo Valve
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Or equal.

B. Bronze Check Valves, General: MSS SP-80.

C. Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

D. Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

E. Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.5 GRAY-IRON SWING CHECK VALVES

A. Manufacturers:

1. Gray-Iron Swing Check Valves with Metal Seats:

- a. Apollo Valve
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Stockham Div.
- d. Hammond Valve.
- e. NIBCO INC.
- f. Or equal

2. Gray-Iron Swing Check Valves with Composition to Metal Seats:

- a. Apollo Valve
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Stockham Div.
- d. Watts Industries, Inc.; Water Products Div.
- e. Or equal

B. Gray-Iron Swing Check Valves, General: MSS SP-71.

- C. Class 125, gray-iron, swing check valves with metal seats.
 - D. Class 125, gray-iron, swing check valves with composition to metal seats.
- 2.6 SPRING-LOADED, LIFT-DISC CHECK VALVES
- A. Manufacturers:
 - 1. Globe Lift-Disc Check Valves:
 - a. Apollo Valve
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Or equal
 - B. Lift-Disc Check Valves, General: FCI 74-1, with spring-loaded bronze or alloy disc and bronze or alloy seat.

2.7 BRONZE GATE VALVES

- A. Manufacturers:
 - 1. Bronze, Rising-Stem, Solid-Wedge Gate Valves:
 - a. Apollo Valve
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Hammond Valve.
 - e. NIBCO INC.
 - f. Or equal.
- B. Bronze Gate Valves, General: MSS SP-80, with ferrous-alloy handwheel.
- C. Class 150, Bronze Gate Valves: Bronze body with rising stem and bronze solid wedge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair valves that will not turn properly; replace with new valves. Where a new valve leaks around the stem, repair by tightening the packing by 1/8th to 1/4 turn. If this does not stop the leak, replace the packing washer.

3.2 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or gate valves.
 - 2. Throttling Service: Ball valves.
 - 3. Pump Discharge: Spring-loaded, lift-disc check valves.
- B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.
- C. Low Pressure, Compressed Air Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two-piece, 400 psig CWP rating, copper alloy.
 - 2. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze.
- D. Domestic Water Piping: Use the following types of valves:
 - 1. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
 - 2. Lift Check Valves, NPS 2 and Smaller: Class 150, horizontal or vertical, bronze.
 - 3. Swing Check Valves, NPS 2 and Smaller: Class 150, bronze.
 - 4. Gate Valves, NPS 2 and Smaller: Class 150, bronze.
 - 5. Butterfly Valves, NPS 2 1/2" and Larger: Butterfly Valves with 200 psi with stem extension or Gate Valves: Class 125#.
- E. Sanitary Waste and Storm Drainage Piping: Use the following types of valves:
 - 1. Swing Check Valves, NPS 2-1/2 and Larger: Class 125, gray iron.
- F. Select valves, except wafer and flangeless types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, solvent weld for CPVC/PVC.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded ends, solder ends, grooved, or flanged, solvent weld for CPVC/PVC.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Grooved, Flanged or threaded ends.
6. For Steel Piping, NPS 5 and Larger: Grooved or Flanged ends.
7. For Grooved End, Copper Tubing and Steel Piping: Valve ends may be grooved.

3.3 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.
- F. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: In horizontal position with hinge pin level.
 2. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

- A. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 220523

SECTION 220529 - HANGERS & SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

- A. Product Data: For the following:
 1. Steel pipe hangers and supports.
 2. Fiberglass pipe hangers.
 3. Thermal-hanger shield inserts.
 4. Pipe positioning systems.
- B. Shop Drawings: Show fabrication and installation details for the following:
 1. Trapeze pipe hangers. Include Product Data for components.
 2. Metal framing systems. Include Product Data for components.
 3. Fiberglass strut systems. Include Product Data for components.
 4. Pipe stands. Include Product Data for components.
 5. Equipment supports.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - a. AWS D1.2, "Structural Welding Code--Aluminum."
 - b. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 2. ASME Boiler and Pressure Vessel Code: Section IX. PART

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHD Manufacturing, Inc.
 - 4. Unistrut, a part of Atcore International
 - 5. Grinnell Mechanical Products, a Tyco International Company
 - 6. National Pipe Hanger Corporation
 - 7. or Equal
- C. Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.
- E. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- F. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. Unistrut Corp.; Tyco International, Ltd.
 - 4. Grinnell Mechanical Products
 - 5. National Pipe Hanger Corporation
 - 6. Or Equal
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 HANGER SHIELD INSERTS

- A. Prefabricated fiberglass insert (similar to Johns Manville Hi-Lo insert)
- B. Pre-fabiated or engineered system:
- C. Snap N Shields
- D. Aquatherm Pro-Shield
- E. Or Equal

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. ERICO/Michigan Hanger Co.
 - 2. PHS Industries, Inc.
 - 3. Pipe Shields, Inc.
 - 4. Carpenter & Patterson Inc.
 - 5. Erico (Michigan Hanger)
 - 6. Or equal
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel or zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. ITW Ramset/Red Head.
 - d. Blue Banger (ISAT/Strongtie)
 - e. Bang it or Wood Knocker Concrete Inserts (Powers Fasteners)
 - f. Or Equal
- B. Rod Hanger Anchors: One piece, zinc-plated carbon steel threaded fastening system for use in suspending threaded rod in concrete. (ICC-ES; ESR-2526) Tested in accordance with ACI 355.2 / ASTM E 488; ICC-ES AC193.

2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: plastic
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, trapeze or roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.
- G. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:

- a. MIRO Industries.
- b. Or Equal

2.8 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Manufacturers:
 - 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.
 - 4. Or Equal

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic- cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength. PART

3 PART 3- EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 - 2. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 3. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 - 4. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 - 5. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. C-Clamps (MSS Type 23): For structural shapes.
5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- N. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with the following:
 1. Attach clamps and spacers to piping.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal- hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 5. Pipes NPS 8 and Larger: Include wood inserts.
 6. Insert Material: Length at least as long as protective shield.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

END OF SECTION 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.

- B. Related Requirements:

1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.3 DEFINITIONS

- A. Designated Seismic System: A plumbing component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.
- B. IBC: International Building Code.

- C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[and wind-force-]restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an agency acceptable to authorities having jurisdiction.
5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each seismic-restraint and wind-load protection device, including items that are required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic and wind-load restraint, and vibration isolator, and isolation base selection: Select vibration isolators, seismic and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
 - b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
 - c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
 - d. Seismic Design Calculations: Submit all input data and loading calculations prepared in "Performance Requirements" Article in "Seismic Design Calculations" Paragraph.
 - e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared in "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
 - f. Qualified Professional Engineer: All designated-design submittals for seismic and wind-load-restraint calculations are to be signed and sealed by qualified New Jersey professional engineer responsible for their preparation.

2. Seismic- and Wind-Load Restraint Detail Drawing:
 - a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
3. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
4. All delegated-design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation [and wind-load reinforcement]device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For New Jersey professional engineer and testing agency.
- C. Welding certificates.
- D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data
- E. Field quality-control reports:
- F. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
 1. Provide equipment manufacturer's written certification for each designated active plumbing seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and

- AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction ASCE/SEI 7-16.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-16.
 3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
- G. Wind-Force Performance Certification: Provide special certification for plumbing components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.
1. Provide equipment manufacturer's written certification for each designated plumbing device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
 2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
 3. Plumbing systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic and Wind-Load Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic and wind-load control system.
 1. Seismic and Wind-Load Performance: Equipment shall withstand the effects of earthquake motions and high wind events determined in accordance with ASCE/SEI 7-16. Refer to Plumbing Contract Drawings for additional information.

2. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amber/Booth Company, Inc.
 - b. Kinetics Noise Control.
 - c. Mason Industries.
 - d. Or Equal
- B. Seismic Design Calculations:
 1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-16 or other seismic calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the section text.
 - a. Data indicated below to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
 - c. Refer to Plumbing Contract Drawings for additional information.
 2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
 - a. Horizontal Seismic Design Force F_p : Value is to be calculated by Delegated-Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation.
 - 1) S_{DS} = Spectral Acceleration: Refer to Plumbing Contract Drawings for additional information.
 - 2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
 - 3) I_p = Component Importance Factor: See Drawing Schedule for each component.
 - 4) W_p = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from each component submittal.
 - 5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
 - 6) z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated-Design Contractor. For items at or below the base, "z" shall be taken as zero.
 - 7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.
 - b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
 - c. Seismic Relative Displacement D_{pi} : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:

- 1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated-Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
 - 2) I_e = Structure Importance Factor: Refer to Plumbing Contract Drawings for additional information.
 - 3) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
 - 4) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
 - 5) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
 - 6) h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 7) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 8) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
 - 9) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
 - 10) h_{sx} = Story Height Used in the Definition of Allowable Drift Δ_a : See Drawings Schedules for each component.
- d. Component Fundamental Period T_p : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:
- 1) Refer to Plumbing Contract Drawings for additional information.
 - 2) W_p = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
 - 3) g = Gravitational Acceleration: 32.17 fps^2 .
 - 4) K_p = Combined Stiffness of the Component, Supports, and Attachments: Determined by delegated-design seismic engineer. .
3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.
- a. Horizontal Seismic Design Force F_p : Calculated by Delegated-Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
- 1) S_{DS} = Spectral Acceleration: Refer to Plumbing Contract Drawings for additional information.
 - 2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
 - 3) I_p = Component Importance Factor: See Drawing Schedule for each component.
 - 4) W_p = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from equipment submittal.
 - 5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.

- 6) z = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, " z " shall be taken as zero.
 - 7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.
 - b. Vertical Seismic Design Force: Calculate by Delegated- Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.
 - c. Seismic Relative Displacement D_{pl} : Calculate by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
 - 1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated-Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
 - 2) I_e = Structure Importance Factor: Refer to Plumbing Contract Drawings for additional information.
 - 3) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
 - 4) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
 - 5) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
 - 6) h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data;
 - 7) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 8) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
 - 9) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
 - 10) h_{sx} = Story Height Used in the Definition of the Allowable Drift Δ_a : See Schedule for each component.
4. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.
 - a. Horizontal Seismic Design Force F_p : Calculated by Delegated-Design Contractor by ASCE/SEI 7-16, Equation 13.3-1. Factors below must be obtained for this calculation.
 - 1) S_{DS} = Spectral Acceleration: Refer to Plumbing Contract Drawings for additional information.
 - 2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
 - 3) I_p = Component Importance Factor: See Drawing Schedule for each component.
 - 4) W_p = Component Operating Weight: Obtain by Delegated-Design Contractor for each component from component submittal.

- 5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
 - 6) z = Height in Structure of Point of Attachment of Component for the Base: Determine by Delegated-Design Contractor for each component from Project Drawings. For items at or below the base, " z " shall be taken as zero.
 - 7) h = Average Roof Height of Structure for the Base: Determine by Delegated-Design Contractor from Project Drawings.
- b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.
- c. Seismic Relative Displacement D_p : Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
- 1) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
 - 2) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
 - 3) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
 - 4) h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 5) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
 - 6) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
 - 7) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
 - 8) h_{sx} = Story Height Used in the Definition of the Allowable Drift Δ_a : See Drawing Schedule for each component.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-16 or other wind-force calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
 - a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
 - b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
2. Design wind pressure " p " for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations according to one of the following, as appropriate:

- a. PART 1: Low-Rise Buildings.
 - b. PART 2: Low-Rise Buildings (Simplified).
 - c. PART 3: Buildings with "h" less than 60 feet.
 - d. PART 4: Buildings with "h" greater than 60 feet and less than 160 feet.
 - e. PART 5: Open Buildings.
3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
 - a. Refer to Plumbing Contract Drawings for additional information.
 - b. "Risk category" value is determined by plumbing engineer from Project structural engineer or ASCE/SEI 7-16, Table 1.5-1.
4. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
 - a. PART 1: Low-Rise Buildings.
 - b. PART 2: Low-Rise Buildings (Simplified).
 - c. PART 3: Buildings with "h" greater than 60 feet.
 - d. PART 4: Buildings with "h" less than 160 feet.
 - e. PART 5: Open Buildings.
5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
 - a. Refer to Plumbing Contract Drawings for additional information.
6. Design Wind Force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 6.
 - a. Refer to Plumbing Contract Drawings for additional information.
- D. Consequential Damage: Provide additional seismic and wind-force restraints for suspended plumbing components or anchorage of floor, roof or wall mounted plumbing components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential plumbing component will not cause the failure of any other essential architectural, mechanical or electrical building component.
- E. Fire/Smoke Resistance: Seismic and wind-load restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.
- F. Component Supports:
 1. Load Ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
 2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-16 Section 13.6.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
4. Surface Pattern: Smooth, ribbed, or waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
2. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts.

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with [threaded mounting holes] [elastomeric pad].
 - c. Internal leveling bolt that acts as blocking during installation.
2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing
 - 1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- Thick Neoprene:
 - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

- A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- Thick Neoprene
 - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows
 - 1. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 - 2. Maximum Natural Frequency: 3 Hz.
 - 3. Operating Pressure Range: 25 to 100 psig.
 - 4. Burst Pressure: At least three times manufacturer's published maximum operating pressure.

5. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint:

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Internal leveling bolt that acts as blocking during installation.
2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
7. Operating Pressure Range: 25 to 100 psig
8. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
9. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

- A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Post-installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 2021 IBC. Preset concrete inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
 2. Anchors in Masonry: Design in accordance with TMS 402.
 3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 4. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.16 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

- A. Seismic and Wind-Load Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections, Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-16, Ch. 13.
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW), which is not vibration isolated.
 - 1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

- A. Provide preset concrete inserts, which are seismically prequalified in accordance with ICC-ES AC466 testing.
- B. Comply with ANSI/MSS 58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

- A. Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation, wind-load control, and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static, wind load, and seismic load within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROL, WIND-LOAD CONTROL, AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators, wind-load restraints, and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.
- E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:
 - 1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint and wind-load-restraint devices using methods approved by [an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet

H. Install seismic and wind-load restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install seismic and wind-load restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install automatic leveling valve into each air isolator.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered air supply.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate dimensions of steel equipment rails, bases, and concrete inertia bases, with requirements of isolated equipment specified in this and other Sections. Where dimensions of bases are indicated on Drawings, they may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 1. Perform tests and inspections with the assistance of a factory-authorized service representative.

2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 5. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 6. Test to 90 percent of rated proof load of device.
 7. Measure isolator restraint clearance.
 8. Measure isolator deflection.
 9. Verify snubber minimum clearances.
 10. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Utilize manufacturer's standard preprinted captions. Manufacturer's pre-printed labels shall coordinate names, abbreviations and other designations with corresponding designations indicated. Use numbers, letters and terms indicated for proper identification, operation, and maintenance of plumbing systems.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick,

2. Letter Color: White.
 3. Background Color: Black.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
1. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 2. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 3. Fasteners: Stainless-steel rivets or self-tapping screws
 4. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- D. Label Content: Include equipment's Drawing designation or unique equipment number, capacities as noted on the drawing schedules.
- E. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules). Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

PART PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and/or control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. Identification of potable and non-potable water.
 - a. In all buildings where two or more water distribution systems, one potable water and the other non-potable water, are installed, each system shall be identified either by color marking or metal tags as required by ASME A13.1. Reclaimed water systems shall be identified using color coded Pantone Purple 522C and marked with the statement "NONPOTABLE WATER - NOT FOR HUMAN CONSUMPTION".
- B. Pipe Label Color: Refer to ASME (ANSI) Standard A13.1-2007.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, shutoff valves. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape: Brass valve tag, 1 1/2 inches, round, with stamped or engraved lettering.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
 - 2. Adhesives.
 - 3. Sealants.
 - 4. Field-applied jackets.
 - 5. Protective Shielding Guards

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. LEED Submittal:
 - 1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
- C. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.
- D. Qualification Data: For qualified Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- B. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- F. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000(Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA Inc.; Aero seal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:

- a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A- 3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.

2.3 SEALANTS

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: White.

2.4 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - e. Or Equal
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White.
 - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
- C. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.

- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a

- smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. But each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
3. Contractor Option: PVC Fitting Covers with blanket fiberglass inserts.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

- B. Comply with the energy code for minimum requirements for “hot” systems, greater than or equal to 105°F:

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		≥Nominal Pipe or Tube Size, in.				
	Conductivity, Btu-in/h-ft ² -°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
141 to 200	0.25 to 0.29	125	1.5	1.5	2.0	2.0	2.0
105 to 140	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/K)^{K/k} - 1]$, where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu-in/h-ft²-°F); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. These thicknesses are based on *energy efficiency* considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.

c. For *pipng* smaller than 1.5 in. and located in partitions within *conditioned spaces*, reduction of these thicknesses by 1 in. shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 1 in.

d. For direct-buried heating and hot-water *system piping*, reduction of these thicknesses by 1.5 in. shall be permitted (before thickness adjustment required in footnote [a]) but not to thicknesses below 1 in.

e. The table is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic pipes having *thermal resistance* greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per metre than a steel pipe of the same size with the insulation thickness shown in the table.

- C. Comply with the energy code for minimum requirements for “cold” systems, less than or equal to ambient conditions, 70°F:

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		Nominal Pipe or Tube Size, in.				
	Conductivity, Btu-in/h-ft ² -°F	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
40 to 60	0.21 to 0.27	75	0.5	0.5	1.0	1.0	1.0
<40	0.20 to 0.26	50	0.5	1.0	1.0	1.0	1.5

a. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/K)^{K/k} - 1]$, where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu-in/h-ft²-°F); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b. These thicknesses are based on *energy efficiency* considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

c. For direct-buried cooling *system piping*, insulation is not required.

d. The table is based on steel pipe. Nonmetallic pipes schedule 80 thickness or less shall use the table values. For other nonmetallic pipes having *thermal resistance* greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown in the table.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:

1. Mineral Fiber, Preformed Pipe Insulation, Type 1: See 3.9-C, ½” to 1-1/2” thick based on pipe diameter
2. Flexible Elastomeric: See 3.9-C, 1/2 inch to 1-1/2” thick based on pipe diameter

- B. Domestic Hot and Recirculated Hot Water:

1. Mineral-Fiber, Preformed Pipe Insulation, Type I: See 3.9-B, 1” to 1-1/2” thick based on pipe diameter

- C. Horizontal Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall begin at the base of the roof drain and include all horizontal piping and elbows at changes in direction from the horizontal to the vertical and shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1" thick.
 - b. Insulate only the first 10 feet of overflow piping.
- D. Roof Drain and Overflow Drain Bodies:
 1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1" thick.
- E. Condensate and Equipment Drain Water below 60 Deg F and Floor drain bodies and traps receiving condensate for the length of the system from the p-trap of the drain:
 1. Flexible Elastomeric: See 3.9-C, 1/2" to 1" thick based on pipe diameter.
- F. Condensate Force Main System:
 1. Flexible Elastomeric: See 3.9-C, 1/2" to 1" thick based on pipe diameter.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2" thick
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2" thick
- B. Domestic Hot and Recirculated Hot Water:
 1. NPS 2 inches and smaller: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 2" thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2" thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Exposed:
 1. PVC: 20 mils thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Exposed:

1. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 220700

SECTION 220963 - MEDICAL GAS ALARMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Master alarm panels.
 - 2. Area alarm panels.
 - 3. Local alarm panels.
 - 4. Computer-interface cabinet.

1.3 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Qualification Data: For installer and testing agency.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For alarm panels to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Qualify Installers for air, vacuum, and gas piping systems for healthcare facilities according to ASSE Standard #6010 for medical-gas-system installers.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the air, vacuum, and gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel for air, vacuum, and gas piping systems for healthcare facilities according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Gas and Vacuum Systems Monitored:

1. Carbon dioxide, designated "medical carbon dioxide."
2. Medical compressed air, designated "medical air."
3. Medical-surgical vacuum, designated "medical vacuum."
4. Nitrogen, designated "medical nitrogen."
5. Nitrous oxide, designated "medical nitrous oxide."
6. Oxygen, designated "medical oxygen."
7. Waste anesthetic gas disposal, designated "WAGD."

2.2 GENERAL REQUIREMENTS FOR ALARM PANELS

- A. Description: Factory wired with audible and color-coded visible signals to indicate specified functions.
 1. Mounting: Recessed installation.
 2. Enclosures: Fabricated from minimum 1.2-mm thick steel with knockouts for electrical and piping connections.
- B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
 1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.
- D. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 1. Low-Pressure Operating Range: 0 to 100 psig.
 2. High-Pressure Operating Range: Up to 250 psig.
- E. Carbon-Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon-monoxide level rises above 10 ppm.

- F. Vacuum Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

- 1. Vacuum Operating Range: 0 to 30 in. Hg.

2.3 MASTER ALARM PANELS

- A. Master Alarm Panels: Separate trouble alarm signals and indicators for each system.

- 1. Standards: Comply with NFPA 99 and UL 544.
 - 2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. Include alarm signals when the following conditions exist:
 - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon-monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
 - b. Medical Vacuum: Vacuum drops below 12 in. Hg and backup vacuum pump is in operation.
 - c. WAGD: Vacuum drops below 12 in. Hg.

2.4 AREA ALARM PANELS

- A. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals and indicators for each system.

- 1. Standards: Comply with NFPA 99 and UL 544.
 - 2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. Include alarm signals when the following conditions exist:
 - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.
 - b. Medical Vacuum: Vacuum drops below 12 in. Hg.
 - c. WAGD: Vacuum drops below 12 in. Hg.
 - d. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.
 - e. Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig.
 - f. Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig.
 - g. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

2.5 LOCAL ALARM PANELS

- A. Local Alarm Panels: Separate trouble alarm signals and indicators for each system.

- 1. Standards: Comply with NFPA 99 and UL 544.
 - 2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. Include alarm signals when the following conditions exist:

- a. Medical Air: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon-monoxide level rises above 10 ppm, and the following:
 - 1) Oil-Free, Rotary-Screw Air Compressor: High discharge-air temperature and high water level in receiver.
- b. Medical Vacuum: Vacuum drops below 12 in. Hg, backup vacuum producer is in operation, and high water level is in receiver.
- c. WAGD: Vacuum drops below 12 in. Hg, backup vacuum producer is in operation, and high water level is in receiver.

2.6 COMPUTER-INTERFACE CABINET

A. Description:

- 1. Wall-mounted, welded-steel, control cabinet with gasketed door.
- 2. Mounting brackets.
- 3. Grounding device.
- 4. White-enamel finish.
- 5. Factory-installed signal circuit boards.
- 6. Power transformer.
- 7. Circuit breaker.
- 8. Wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

PART 3 - EXECUTION

3.1 ALARM-PANEL INSTALLATION

- A. Install alarm panels in locations required by and according to NFPA 99.
- B. Install computer-interface cabinet with connection to alarm panels and facility computer.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 226113 "Compressed-Air Piping for Laboratory and Healthcare Facilities," Section 226213 "Vacuum Piping for Laboratory and Healthcare Facilities," and Section 226313 "Gas Piping for Laboratory and Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to alarm panels, allow space for service and maintenance.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment" and according to NFPA 99.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning panels and equipment.
- D. Alarm panels will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

- A. Adjust initial alarm panel pressure and vacuum set points.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain alarm panels.

END OF SECTION 226400

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Specialty valves.
 - 3. Transition fittings.
 - 4. Dielectric fittings.
 - 5. Escutcheons.
 - 6. Sleeves and sleeve seals.
 - 7. Wall penetration systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
 - 4. HVAC hydronic piping.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.
- C. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 DEFINITIONS

- A. Water Service Piping: Water piping outside building that conveys water to building (by Site Subcontractor)
- B. Service Entrance Piping: Water piping at entry into building between water service piping and water distribution piping (by Plumbing Subcontractor, beginning at 5'-0" outside of building).
- C. Water Distribution Piping: Water piping inside building that conveys water to fixtures and equipment throughout the building.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Copper, Grooved-End Fittings: ASTM B75 copper tube or ASTM B584 bronze castings.
 - 4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 5. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - 6. Copper Compression Fittings: ASTM B88, Seamless Copper Water Tube, as indicated in "Section 4: Compression fittings on copper and stainless-steel tubing" Guide
 - 7. Mechanically Formed, Copper-Tube-Outlet Joints: 90-degree branching from main runs of pipe may utilize mechanically formed copper-tube-outlet joints in accordance with manufacturer recommended procedures.
 - 8. Copper Pressure-Seal-Joint Fittings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Elkhart Products
 - 2) NIBCO INC.
 - 3) Viega; Plumbing and Heating Systems.
- b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O- ring seal in each end.
 - c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- C. Ductile-Iron, Mechanical- or Push-on-Joint Fittings: AWWA C110, ductile- or gray-iron standard pattern; or AWWA C153, ductile-iron compact pattern; with 250-psig minimum pressure rating and AWWA C104 cement-mortar lining. Include AWWA C111 ductile- or gray-iron glands, rubber gaskets, and steel bolts with mechanical-joint fittings. Include AWWA C111 rubber gaskets with push-on-joint fittings
- D. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends conforming to AWWA C110 or AWWA C153. Include 2 gasketed ball-joint sections, 1 or more gasketed sleeve sections, 250-psig minimum working-pressure rating, and AWWA C550 epoxy interior coating. Assemble components for offset and expansion indicated. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.
- E. Ductile-Iron, Grooved-End Fittings: ASTM A47 malleable-iron castings or ASTM A536 ductile-iron castings with cement-mortar lining or AWWA C550 interior coating and dimensions matching ductile-iron pipe.
- F. Ductile-Iron Flanged Fittings: AWWA C110, ductile- or gray-iron standard pattern; with 250-psig minimum pressure rating and AWWA C104 cement-mortar lining.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Materials: ASTM B 32, lead-free alloys. Include water flushable flux according to ASTM B 813.
- D. Brazing Filler Metal: AWS A5.8, BCuP, copper phosphorus or BAg, silver classification.

- E. Copper, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
- F. Ductile-Iron, Keyed Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
- G. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

2.4 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.5 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dresser, Inc.; Dresser Piping Specialties.
 - b. JCM Industries.
 - c. Viking Johnson; c/o Mueller Co.
 - d. Or Equal
- D. Plastic-to-Metal Transition Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.

- c. Spears Manufacturing Company.
 - d. Or Equal
 - 2. Description: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Colonial Engineering, Inc.
 - b. NIBCO INC.
 - c. Spears Manufacturing Company.
 - d. Or Equal
 - 2. Description: CPVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Flanges:
 - 1. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 150 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- C. Dielectric-Flange Kits:
 - 1. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- D. Dielectric Couplings:
 - 1. Description:
 - a. Galvanized-steel coupling.
 - b. Pressure Rating: 300 psig at 225 deg F.

- c. End Connections: Female threaded.
- d. Lining: Inert and noncorrosive, thermoplastic.

E. Dielectric Nipples:

- 1. Description:
 - a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig at 225 deg F.
 - c. End Connections: Male threaded or grooved.
 - d. Lining: Inert and noncorrosive, propylene.

2.7 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

2.8 SLEEVES

- A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.
- D. Engineered products for the appropriate UL ratings of walls or floors. Install per manufacturer's instructions and UL listing for partition or floor.
 - 1. Hilti
 - 2. 3M
 - 3. Pro Set
 - 4. Or Equal
 - 5. Or where alternate products are allowed in detail.
- E. Where a plastic product penetrates a wall assembly and no UL rated detail is available, sound engineering judgement shall be used, and the solution shall be submitted for review.
- F. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

G. Wall Penetrations. Sleeves are not required if the following requirements are met.

- a. The penetration is not exposed to public view
- b. Penetrations that are exposed to public view have an escutcheon.
- c. Firestopping, where required, meets the UL Listing for the wall rating.
- d. Proper acoustic sealing is installed, where required.

2.9 SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Carbon steel.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.10 WALL PENETRATION SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: SIGMA.
- B. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
1. Carrier-Pipe Deflection: Up to 5 percent without leakage.
 2. Housing: Ductile-iron casting with hub, water stop, anchor ring, and locking devices. Include gland, bolts, and nuts.
 3. Housing-to-Sleeve Gasket: EPDM rubber.
 4. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber.
 5. Pipe Sleeve: AWWA C151, ductile-iron pipe or ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe.

2.11 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- F. Install domestic water piping level without pitch and plumb.
- G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping adjacent to equipment and specialties to allow service and maintenance.
- L. Install piping to permit valve servicing.

- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- N. Install piping free of sags and bends.
- O. Install fittings for changes in direction and branch connections.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- R. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- T. Exposed drain piping in finished areas shall be chrome plated.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- E. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

- G. FUSION WELDING OF JOINTS: Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
 - 1. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
 - 2. Prior to joining, the pipe and fittings shall be prepared in accordance with F 2389 and the manufacturer's specifications.
 - 3. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.
- H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 SERVICE ENTRANCE PIPING INSTALLATION

- A. Extend service entrance piping to exterior water service piping in sizes and locations indicated for service entrances into building. Refer to Section 330000 - "Utilities" for water service piping.
- B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each service entrance pipe per local Utility Code requirements.
- C. Ductile-Iron, Service Entrance Piping: Comply with AWWA C600. Install buried piping between shutoff valve and connection to water service piping with restrained joints. Anchor pipe to wall or floor at entrance. Include thrust-block supports at vertical and horizontal offsets.

3.5 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops.
- C. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.6 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.

- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.7 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - 3. Construct trapeze piping in accordance with MSS-SP 58 and 69 requirements. Design trapeze to support all piping weights including weight of water. Use U-bolts, Cush Clamps or other means to attach piping to trapeze. After trapeze installation, loosen shipping connections to allow pipe expansion
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Where hanger span extension products are available and allowable by the manufacturer recommendations may be utilized.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.

- F. Install supports for vertical copper tubing every 10 feet.
- G. Support piping and tubing not listed in this article according to Florida Plumbing Code, MSS SP-69 and manufacturer's written instructions.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2- 1/2 and larger.

3.10 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3.11 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required in the following:
 1. Concealed, Interior Installation

2. Concealed, Exterior Installation
 3. Exposed Interior Installation where escutcheon has been provided.
 4. Where UL Listed fire stopping system or assemblies are utilized to meet wall rating
 5. Where acoustic sealing system or assemblies are utilized to meet wall rating.
 6. Core drilled penetrations.
- C. Where sleeves are provided or mounted on the piping prior to the sheet rock finishing, the sheet rock installers, shall position the sleeve and provide sheetrock to within $\frac{1}{4}$ " to $\frac{1}{2}$ " of the outside of the sleeve and finish the sheet rock with tape and joint compound tight to outside of the sleeve per the appropriate Gypsum Association Publication GA-214 Level, or finish in accordance with the UL Listing. Where sleeves are not required, the sheetrock installer shall finish the sheetrock to within $\frac{1}{4}$ " to $\frac{1}{2}$ " of outside of the piping.
- D. Permanent sleeves are not required for holes formed by removable PE sleeves.
- E. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- F. Install sleeves in new partitions, slabs, and walls as they are built.
- G. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- H. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.
- I. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using wall penetration systems specified in this Section.
- J. Seal space outside of sleeves in concrete slabs and walls with grout.
- K. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- L. Install sleeve materials according to the following applications:
1. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE, Steel Pipe, Steel (Sheet-Metal), Pre-engineered or other products per UL listings.
 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Stack sleeve fittings. Steel Pipe, Steel (Sheet-Metal), Pre-engineered or other products per UL listings.
 - a. Extend sleeves 2 inches above finished floor level.
 - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
 - c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
 4. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE, Steel Pipe, Steel (Sheet-Metal), Pre-engineered or other products per UL listings.
 5. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Cast-iron wall pipe sleeves for pipes NPS 6 and larger.
 - c. Install sleeves that are large enough to provide 1-inch annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - d. Do not use sleeves when wall penetration systems are used.
 6. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. Steel pipe sleeves for pipes smaller than NPS 6.
 - b. Galvanized-steel sheet sleeves for pipes NPS 6 and larger.
- M. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.12 SLEEVE SEAL INSTALLATION

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.13 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.14 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 1.5 times the operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow standing for two hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.15 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.16 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to the local health department or a bacteriological laboratory recognized and acceptable to the Architect. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit a letter and laboratory reports of purging and disinfecting activities by the organization certifying successful completion of the sterilization. Submit all reports to the Architect.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.17 PIPING SCHEDULE

- #### A.
- Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building service piping, NPS 3 and smaller, shall be one of the following:
 - 1. Hard or Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 shall be one of the following:
 - 1. Hard or Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
 - 2. Ductile-iron pipe and fittings, and mechanical or push-on joints.
- F. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard or Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
- G. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- H. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- I. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings and soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L; grooved-joint copper-tube appurtenances; and grooved joints.

3.18 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Contract Drawings and Equipment Schedules for additional information, requirements, and details

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Temperature-actuated water mixing valves.
 - 6. Strainers.
 - 7. Outlet boxes.
 - 8. Hose bibbs.
 - 9. Wall hydrants.
 - 10. Water hammer arresters.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping to include in emergency, Operation and Maintenance Manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - e. Or Equal
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts Industries, Inc.; Water Products Div.
 - b. Woodford Manufacturing Company.
 - c. Zurn Plumbing Products Group; Light Commercial Operation.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - e. Or Equal
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Zurn Plumbing Products Group; Wilkins Div.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Or Equal
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Configuration: See Plumbing Drawings.

B. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Zurn Plumbing Products Group; Wilkins Div.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Or Equal
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.
3. Furnish to the owner one (1) full rebuild kit for each BFP device.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Zurn Plumbing Products Group; Wilkins Div.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Or Equal
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 300 psig.
4. Design Inlet Pressure: See Plumbing Drawings.
5. Design Outlet Pressure Setting: See Plumbing Drawings.
6. Body: Ductile iron with interior lining complying with AWWA C530 or that is FDA approved for NPS 4 and NPS 6.
7. End Connections: Flanged for NPS 4 and NPS 6.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thermomegatech Model #CSUA-XX-1XX-CV1
2. Body: Brass or bronze.
3. Size: Same as connected piping.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Powers; a Watts Industries Co.
 - b. Symmons Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - e. Or Equal
 2. Standard: ASSE 1017.
 3. Pressure Rating: 125 psig.
 4. Type: Thermostatically controlled water mixing valve.
 5. Material: Bronze body with corrosion-resistant interior components.
 6. Connections: Threaded inlets and outlet.
 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 8. Tempered-Water Setting: See Plumbing Drawings.
 9. Tempered-Water Design Flow Rate: See Plumbing Drawings.
 10. Valve Finish: Chrome plated.
- B. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Leonard Valve Company.
 - b. Powers; a Watts Industries Co.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - e. Or Equal
 2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
 3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
 4. Body: Bronze body with corrosion-resistant interior components.
 5. Temperature Control: Adjustable.
 6. Inlets and Outlet: Threaded.
 7. Finish: Rough or chrome-plated bronze.
 8. Tempered-Water Setting: See Plumbing Drawings.
 9. Tempered-Water Design Flow Rate: See Plumbing Drawings.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum, unless otherwise indicated.

2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2- 1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Drain: Factory-installed, hose-end drain valve.

2.7 OUTLET BOXES

A. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sioux Chief Manufacturing Company
 - b. Acorn Engineering Company.
 - c. IPS Corporation.
 - d. Bradley, Inc.
 - e. Or Equal
2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.8 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Woodford Manufacturing Company.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
 - f. Or Equal
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.

7. Pressure Rating: 125 psig.
8. Vacuum Breaker: Integral nonremovable, drainable, hose- connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome plated.
10. Finish for Finished Rooms: Chrome plated.
11. Operation for Equipment Rooms: Wheel handle.
12. Operation for Finished Rooms: Operating key.
13. Include operating key with each operating-key hose bibb.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Woodford Manufacturing Company.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
 - f. Or Equal
2. Standard: ASME A112.21.3M for concealed outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4.
7. Description: See Plumbing Drawings.
8. Operating Keys(s): One with each wall hydrant.

2.10 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 125-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.

2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.11 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Precision Plumbing Products
 - b. Sioux Chief Manufacturing Company
 - c. Josam Company.
 - d. Or Equal
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston with threaded end connection.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.

- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install thermometers and water regulators if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant- treated-wood blocking wall reinforcement between studs. Fire-retardant- treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- H. Install water hammer arresters in water piping according to PDI-WH 201.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Intermediate atmospheric-vent backflow preventers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Calibrated balancing valves.
 - 5. Primary, thermostatic, water mixing valves.
 - 6. Primary water tempering valves.
 - 7. Outlet boxes.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle backflow preventer and double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.

1.3 DEFINITIONS

- A. Sewerage Piping: Building sewer piping outside building that conveys sanitary sewage from building (by Site Contractor).
- B. Service Entrance Piping: Drainage piping at entry into building between outside building sewer piping and inside drainage piping (by Site Contractor).
- C. Drainage and Vent Piping: Piping inside building that conveys wastewater and vapors from fixtures and equipment throughout the building
- D. Force-Main Piping: Drainage piping, under pressure (where required due to local conditions).
- E. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated: Soil, Waste, and Vent Piping: 10-foot head of water
- B. Storm Drainage Systems: 10-foot head of water.
- C. Sewage, Force-Main Piping Systems: 100 psig (only where required due to local conditions).

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

- B. Shop Drawings.
- C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.
- C. Comply with NSF 14, "Plastic Piping System Components and Related Materials", for plastic piping components. Include marking with "NSF- dwv" for plastic drain, waste and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF- sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class. Marked with CISPI collective trademark and be listed by NSF International.
- B. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: CISPI 301. Marked with CISPI collective trademark and be listed by NSF International.
- B. Shielded Couplings: ASTM C 1277 and FM 1680 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel housing or shield, stainless-steel bands/clamps and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Manufacturers:
 - 1) Clamp-All Corp.
 - 2) Husky.
 - 3) Anaco.
 - 4) Proflo
 - 5) Charlotte
 - 6) Tyler
2. Heavy-Duty, FM-Approved, Stainless-Steel Couplings: ASTM C564, Type 304, stainless-steel (AISI) housing; and stainless-steel clamps. Include gasket or bushing.
3. Heavy-Duty, Cast-Iron Couplings: ASTM A48, 2-piece, cast-iron housing; and stainless-steel bolts and nuts. Include gasket.

2.5 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought- copper fittings if indicated.
 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.6 PVC PIPE AND FITTINGS

- A. Solid Wall PVC Pipe: ASTM D2665, drain, waste and vent.
 1. PVC Socket Fittings: ASTM D2665, socket type made to ASTM D3311, drain, waste and vent patterns.
- B. Cellular-Core, Schedule 40, PVC Pipe: ASTM F891, Schedule 40.
 1. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- C. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F891, Series PS 100.

1. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drainpipe.

D. Solvent Cement and Adhesive Primer:

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 DUCTILE IRON PIPE AND FITTINGS

1. Ductile Iron Pipe: AWWA C151.
2. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile or gray-iron glands, rubber gaskets, and steel bolts.

2.8 SPECIAL PIPE FITTINGS

- A. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
- B. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell- and-spigot end sections complying with AWWA C110 or AWWA C153.
- C. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.
- D. Flexible, Transition Couplings for Underground, Nonpressure Piping: ASTM C1173 with elastomeric sleeve. Include ends same sizes as piping to be joined and include corrosion-resistant metal band on each end.
 1. Sleeve Type for Plain-End Piping: Rubber or elastomeric sleeve and stainless-steel band assembly, fabricated to match outside diameters of piping to be joined. Include the following:
 - a. Sleeves for Cast-Iron Soil Piping: ASTM C564 rubber.
 - b. Sleeves for Plastic Piping: ASTM F477 elastomeric seal.
 - c. Sleeves for Dissimilar Piping: Compatible with piping materials to be joined.

- d. Bands: Stainless steel, one at each pipe insert.
- 2. Gasket Type for Dissimilar-End Piping: Rubber or elastomeric compression gasket, made to match inside diameter of pipe or hub, and outside diameter of adjoining pipe. Include the following:
 - a. Gaskets for Cast-Iron Soil Piping: ASTM C564 rubber.
 - b. Gaskets for Plastic Piping: ASTM F477 elastomeric seal.
 - c. Gaskets for Dissimilar Piping: Compatible with piping materials to be joined.
- 3. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
- 4. Manufacturers:
 - a. EBAA Iron Sales, Inc.
 - b. Romac Industries, Inc.
- E. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 1. Manufacturers: SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil, waste and vent piping:
 - 1. 1 1/2-inch: Copper DWV or Type M
 - 2. 2" and larger:
 - a. Hubless cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings and heavy-duty couplings
 - 3. Dissimilar Pipe-Material Couplings: Shielded non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Underground, soil, waste, and vent piping shall be the following:
 - 1. Service class, cast-iron soil piping, SVCI ;gaskets; and gasketed joints.
 - 2. Solid Wall PVC, PVC socket fittings and solvent cemented joints.

3. Dissimilar Pipe-Material Couplings: Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- D. Aboveground, Sewage Force Mains: Use one of the following:
 1. 2- to 4-Inch NPS: Hard copper water tube, Type L (Type B); copper, solder-joint pressure fittings; and soldered joints.
 2. 2- to 4-Inch NPS: Hard copper water tube, Type L (Type B); copper, grooved-end fittings; and copper, keyed couplings.
 3. 2- to 4-Inch NPS: Galvanized steel pipe and cast-iron, threaded fittings.
 4. 2- to 4-Inch NPS: Galvanized steel pipe; steel, grooved-end fittings; and steel, keyed couplings.
 5. 5- and 6-Inch NPS: Hard copper water tube, Type L (Type B); copper, grooved-end fittings; and copper, keyed couplings.
 6. 5- and 6-Inch NPS: Galvanized steel pipe and cast-iron, threaded fittings.
 7. 5- and 6-Inch NPS (DN125 and DN150): Galvanized steel pipe; steel, grooved-end fittings; and steel, keyed couplings.
 8. 5- and 6-Inch NPS (DN125 and DN150): Ductile-iron, grooved-end pipe; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings.
- E. Underground, Sewage-Force-Main, Service Entrance Piping: Use one of the following:
 1. 2- to 3-Inch NPS (DN50 to DN80): Soft copper water tube, Type K (Type A); wrought-copper, solder-joint pressure fittings; and soldered joints.
 2. 2- to 3-Inch NPS (DN50 to DN80): Soft copper water tube, Type L (Type B); wrought-copper, solder-joint pressure fittings; and soldered joints.
 3. 4- and 6-Inch NPS (DN100 and DN150): Ductile-iron pipe; ductile-iron, mechanical- or push-on-joint fittings; rubber gaskets; and mechanical or push-on joints.

3.3 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

- D. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."
- F. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- G. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back-to-back or side by side with common drainpipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- J. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- K. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- L. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

- M. Install underground PVC soil waste and drainage piping according to ASTM D2665.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- E. PVC Non-Pressure Piping Joints: Join according to ASTM D2665.
- F. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Compression Joints: Make with rubber gasket matching class of pipe and fittings.
 - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- G. Grooved Joints: Assemble joints with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- H. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F402 for safe handling during joining of plastic pipe and fittings.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42 clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable clevis hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: Support pipe rolls on trapeze with one of the following:

- a. adjustable clevis hangers
 - b. U-bolts
 - c. Adjustable Pipe Stands.
- B. Install supports according to Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8- inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6: 60 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
 6. Pipe hangers with 10 feet pipe lengths may be increased to 120 inches on center.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 5. NPS 6: 10 feet with 5/8-inch rod.
 6. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they

leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

SECTION 221317 - CONDENSATE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following for condensate waste piping inside the building:
 - 1. Pipe, tube, and fittings.

1.03 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated: Condensate Piping: 10-foot head of water

1.04 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.02 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - 1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground piping, unless otherwise indicated.
- B. Aboveground, Condensate piping shall be the following:
 - 1. Copper DWV tube, copper drainage fittings, and soldered joints:
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
 - b. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

3.03 INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- C. Install engineered Condensate piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- D. Sleeves are not required for Condensate piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

3.04 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42 clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6: 60 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- F. Install supports for vertical condensate piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 5. NPS 6: 10 feet with 5/8-inch rod.
 - 6. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.07 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 3. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building.

Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.08 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221317

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Contract Drawings and Equipment Schedules for additional information, requirements, and details

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Backwater valves.
 - 2. Cleanouts.
 - 3. Floor drains.
 - 4. Trench drains.
 - 5. Roof flashing assemblies.
 - 6. Through-penetration firestop assemblies.
 - 7. Miscellaneous sanitary drainage piping specialties.
 - 8. Flashing materials.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

- A. Horizontal, Cast-Iron Backwater Valves:
 - 1. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - 2. Watts Drainage Products Inc.
 - 3. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 4. Josam Company; Josam Div.
 - 5. Standard: ASME A112.14.1.
 - 6. Size: Same as connected piping.
 - 7. Body: Cast iron.
 - 8. Cover: Cast iron with bolted or threaded access check valve.
 - 9. End Connections: Hub and spigot or hubless.
 - 10. Type Check Valve: Removable, bronze, swing check, factory assembled, or field modified to hang closed.
 - 11. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- B. Drain-Outlet Backwater Valves:
 - 1. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - 2. Watts Drainage Products Inc.
 - 3. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 4. Josam Company; Josam Div.
 - 5. Size: Same as floor drain outlet.
 - 6. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
 - 7. Check Valve: Removable ball float.
 - 8. Inlet: Threaded.
 - 9. Outlet: Threaded or spigot.

2.2 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - 2. Watts Drainage Products Inc.
 - 3. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 4. Josam Company; Josam Div.
 - 5. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 6. Size: Same as connected drainage piping.
- B. Metal Floor Cleanouts:
 - 1. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
 - 2. Watts Drainage Products Inc.
 - 3. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 4. Josam Company; Josam Div.
 - 5. Standard: ASME A112.36.2M for adjustable housing cleanout.
 - 6. Size: Same as connected branch.

C. Cast-Iron Wall Cleanouts:

1. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
2. Watts Drainage Products Inc.
3. Zurn Plumbing Products Group; Specification Drainage Operation.
4. Josam Company; Josam Div.
5. Standard: ASME A112.36.2M. Include wall access.
6. Size: Same as connected drainage piping.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
2. Watts Drainage Products Inc.
3. Zurn Plumbing Products Group; Specification Drainage Operation.
4. Josam Company; Josam Div.
5. Standard: ASME A112.6.3.
6. Body Material: Gray iron.
7. Outlet: Bottom.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Hub Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping:
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.5 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.
- E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- J. Install through-penetration firestop assemblies at floor penetrations.
- K. Assemble hub drain fittings and install with top of hub 1 inch above floor.
- L. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- M. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

- N. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- O. Install vent caps on each vent pipe passing through roof.
- P. Install wood-blocking reinforcement for wall-mounting-type specialties.
- Q. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- R. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Contract Drawings and Equipment Schedules for additional information, requirements, and details

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories, showers and sinks.
 - 2. Laminar-flow faucet-spout outlets.
 - 3. Flush Valves.
 - 4. Toilet seats.
 - 5. Protective shielding guards.
 - 6. Fixture supports.
 - 7. Water closets.
 - 8. Urinals.
 - 9. Lavatories.
 - 10. Sinks.
 - 11. Service basins.

1.3 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Plastic Mop-Service Basins: ANSI Z124.6.
 - 2. Slip-Resistant Bathing Surfaces: ASTM F 462.
 - 3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 4. Stainless-Steel Sinks: ASME A112.19.3.
 - 5. Vitreous-China Fixtures: ASME A112.19.2M.
 - 6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
- G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucets: ASME A112.18.1.
 - 5. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 6. Hose-Coupling Threads: ASME B1.20.7.
 - 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 8. NSF Potable-Water Materials: NSF 61.
 - 9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
- H. Comply with the following applicable standards and other requirements specified for shower faucets:
 - 1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 - 2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 - 3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
 - 4. Faucets: ASME A112.18.1.
 - 5. Hand-Held Showers: ASSE 1014.
 - 6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.

7. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 8. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Dishwasher Air-Gap Fittings: ASSE 1021.
 3. Manual-Operation Flushometers: ASSE 1037.
 4. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Dishwasher Air-Gap Fittings: ASSE 1021.
 2. Off-Floor Fixture Supports: ASME A112.6.1M.
 3. Plastic Toilet Seats: ANSI Z124.5.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Zurn Wilkins
 - b. Chicago Faucets
 - c. T & S Brass and Bronze Works, Inc.
 - d. Sloan Faucets
 - e. Or equal.

2.2 SHOWER FAUCETS

A. Shower Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Powers; a Watts Industries Co.
 - b. Symmons Industries, Inc.
 - c. Or equal.

2.3 SINK FAUCETS

A. Sink Faucets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Zurn Wilkins

- b. Chicago Faucets.
- c. T & S Brass and Bronze Works, Inc.
- d. Sloan
- e. Or equal.

2.4 LAMINAR-FLOW FAUCET-SPOUT OUTLETS

A. Laminar-Flow Faucet-Spout Outlets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chronomite Laboratories, Inc.
 - b. NEOPERL, Inc.
2. Description: Chrome-plated-brass faucet-spout outlet that produces non-aerating, laminar stream. Include male or female thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.5 FLUSH VALVES

A. Flush Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sloan Valve Company.
 - b. Zurn Plumbing Products Group; Commercial Brass Operation.
 - c. Or equal.

2.6 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bemis Manufacturing Company.
 - b. Centoco Manufacturing Corp.
 - c. Olsonite Corp.

2.7 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Smith, Jay R. Mfg. Co.
2. Josam Company.
3. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
4. Zurn Plumbing Products Group; Specification Drainage Operation.

2.8 WATER CLOSETS

A. Water Closets:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.

2.9 URINALS

A. Urinals:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.

2.10 LAVATORIES

A. Wall Mounted Lavatories:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.

B. Countertop Lavatories:

- a. Dupont Corian Solid Surface Countertop and Integral Sink. By millwork contractor. Reference Millwork Specification.

2.11 SINKS

A. Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the into the following:
 - a. Elkay Manufacturing Co.
 - b. Just Manufacturing Company.
 - c. Grifford

2.12 SERVICE BASINS

A. Service Basins:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Stern-Williams Co., Inc.

2.13 Electric Water Coolers:

A. Water Coolers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkay Manufacturing Company
 - b. Haws
 - c. Or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install floor-mounted carriers for wall-mounted fixtures.
 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounted fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounted fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounted fixtures with tubular waste piping attached to supports.
- F. Install floor-mounted, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.
- G. Install counter-mounted fixtures in and attached to casework.
- H. Install fixtures level and plumb according to roughing-in drawings.

- I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- M. Install toilet seats on water closets.
- N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- R. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- T. Set service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."
- U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Division 26 Contractor to ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Division 26 Contractor to connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace or repair damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace or repair damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers, hot-water dispensers and controls. Replace or repair damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets and flush valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.

- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF DOCUMENT 224000

SECTION 224300 - HEALTHCARE PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.
- B. Refer to Contract Drawings and Equipment Schedules for additional information, requirements, and details

1.2 SUMMARY

- A. This Section includes the following medical plumbing fixtures and related components:
 - 1. Fixture supports.
 - 2. Clinical sinks.
 - 3. Plaster sinks.
 - 4. Surgeons' scrub sinks.
 - 5. Outlet boxes.

1.3 DEFINITIONS

- A. Accessible Medical Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.
- C. FRP: Fiberglass-reinforced plastic.
- D. PMMA: Polymethyl methacrylate (acrylic) plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of medical plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow- control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For medical plumbing fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities "Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.
- F. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Plastic Shower Enclosures: ANSI Z124.2.
 - 3. Slip-Resistant Bathing Surfaces: ASTM F 462.
 - 4. Vitreous-China Fixtures: ASME A112.19.2M.

PART 2 - PRODUCTS

2.1 BEDPAN WASHERS

- A. Bedpan Washers
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets.
 - b. T & S Brass and Bronze Works, Inc.
 - c. Zurn Plumbing Products Group; Commercial Brass Operation.
 - d. Or equal.

2.2 CLINICAL SINKS

- A. Wall-Mounting Clinical Sinks:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Eljer.
 - c. Kohler Co.

2.3 OUTLET BOXES

A. Dialysis Equipment Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the following:
 - a. Acorn Engineering Company.
 - b. Bradley Corporation.
 - c. Willoughby
 - d. Whitehall Manufacturing; a division of Acorn Manufacturing Company.
 - e. Or equal.
2. Description: Recessed-mounting outlet box with water supply and drain connections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for medical plumbing fixtures to verify actual locations of piping connections before fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble medical plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install floor mounted carriers for wall-mounting fixtures.
 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings.

- H. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture.
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- K. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- L. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- M. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified herein. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from domestic water piping to medical plumbing fixtures.
- C. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.
- D. Grounding of equipment to be by Division 26.
- E. Wiring for fixtures to be by Division 26.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.
- B. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed medical plumbing fixtures for damage. Replace damaged fixtures

and components.

- D. Test installed fixtures after water systems are pressurized for proper operation. Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace or repair damaged and malfunctioning medical plumbing fixtures, fittings, and controls.
- B. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean medical plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of medical plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF DOCUMENT 224300

SECTION 226113 - MEDICAL AIR PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Medical air piping and specialties designated "medical air," operating at 50 to 55 psig.

1.3 DEFINITIONS

- A. D.I.S.S.: Diameter-index safety system.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. Medical Compressed-Air Piping Systems: Include medical air piping systems.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Medical compressed-air service connections.
 - 2. Medical compressed-air pressure control panels.
 - 3. Medical compressed-air alarm system components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Qualification Data: For installer and testing agency.
- D. Brazing certificates.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For medical air piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.

- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."
- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. ASME Compliance:
 - 1. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at more than 150 psig.
 - 2. Comply with ASME B31.9, "Building Services Piping," for laboratory compressed-air piping operating at 150 psig or less.
- G. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate medical compressed-air service connections with other service connections. Medical vacuum service connections are specified in Division 22 Section "Vacuum Piping for Healthcare Facilities" and medical gas service connections are specified in Division 22 Section "Gas Piping for Healthcare Facilities".

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY,"
- B.

"MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze:
 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - c. Allied - Chemetron
 2. Pressure Rating: 300 psig minimum.
 3. Ball: Full-port, chrome-plated brass.
 4. Seats: PTFE or TFE.
 5. Retain locking-type handle in first subparagraph below if required.
 6. Handle: Lever type with locking device.
 7. Stem: Blowout proof with PTFE or TFE seal.
 8. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Check Valves: In-line pattern, bronze:
 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Allied - Chemetron
 - b. Amico Corporation.
 - c. BeaconMedaes.
 2. Pressure Rating: 300 psig minimum.
 3. Operation: Spring loaded.

4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 2. Pressure Rating: 300 psig minimum.
 3. Ball: Full-port, chrome-plated brass.
 4. Seats: PTFE or TFE.
 5. Handle: Lever type with locking device.
 6. Stem: Blowout proof with PTFE or TFE seal.
 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 8. Pressure Gage: Manufacturer installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation.
 - c. BeaconMedaes.
 2. Interior Finish: Factory-applied white enamel.
 3. Cover Plate: Satin-chrome finish steel with frangible or removable windows.
 4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

2.2 MEDICAL COMPRESSED AIR SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
 - 3. Allied - Chemetron
- B. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
 - c. Double seals that will prevent air leakage.
 - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
 - 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Double seals that will prevent air leakage.
 - c. Cover plate with gas-service label.
 - 3. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - a. Medical Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
 - b. Instrument Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
 - 4. Cover Plates: One piece, metal, with chrome-plated finish and permanent, color-coded, identifying label matching corresponding service.

2.2 MEDICAL COMPRESSED AIR PRESSURE CONTROL PANELS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
 - 3. Allied – Chemetron

- B. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
 - 1. Minimum Working Pressure: 200 psig.
 - 2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
 - 3. Pressure Gages: 0- to 300-psig range.
 - 4. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
 - 5. Before final assembly, provide temporary dust shield and U-tube for testing.
 - 6. Label cover plate "Air Pressure Control."

2.3 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
 - 3. Allied - Chemetron
- B. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
- E. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Operating Range: 0- to 100-psig.
- F. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - 1. Mounting: Recessed installation.

2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inch- thick aluminum, with knockouts for electrical and piping connections.
- G. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
 1. Include alarm signals when the following condition exists:
 - a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.

2.4 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Metraflex, Inc.
- B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 1. Working-Pressure Rating: 200 psig minimum.
 2. End Connections: Threaded copper pipe or plain-end copper tube.

2.5 SLEEVES

- A. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Cast-Brass Escutcheons: With set screw.
 1. Finish: Polished chrome-plated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. Drain Piping: Use one of the following piping materials:
 1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with NFPA 99, ASSE Standard #6010 for installation of compressed-air piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install air and drain piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

- I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Install branch connections to compressed-air mains at an angle of 45 degrees or more above the pipe main. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver.
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install medical compressed-air piping to medical compressed-air service connections specified in this Section, to medical compressed-air service connections in equipment and to equipment specified in other Sections requiring medical compressed-air service.
- P. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- Q. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
- R. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
- B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

3.5 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

- B. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

3.6 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION

- A. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.
- B. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.
- C. Install area alarm panels for medical compressed-air piping system where indicated.
- D. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

3.7 SLEEVE INSTALLATION

- A. Sleeves are not required for core-drilled holes.
- B. Permanent sleeves are not required for holes formed by removable PE sleeves.
- C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using stack sleeve fittings.
 - 1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
 - 2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- D. Install sleeves in new walls and slabs as new walls and slabs are constructed.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.8 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Vertical Piping: MSS Type 8 or 42, clamps.
- B. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer than 100 Feet: MSS Type 43, adjustable, roller hangers.
- C. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- D. Base of Vertical Piping: MSS Type 52, spring hangers.
- E. Support horizontal piping within 12 inches of each fitting and coupling.
- F. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
 - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.
 - 9. NPS 3: 14 feet with 1/2-inch rod.
 - 10. NPS 3-1/2: 15 feet with 1/2-inch rod.
 - 11. NPS 4: 16 feet with 1/2-inch rod.
 - 12. NPS 5: 18 feet with 1/2-inch rod.
 - 13. NPS 6: 20 feet with 5/8-inch rod.
 - 14. NPS 8: 23 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.

3.10 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties.
- B. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99.
 - 1. Medical Air: Black letters on yellow background.

3.11 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.
- B. Tests and Inspections:
 - 1. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blowdown.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive-pressure medical compressed-air piping.
 - f. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical air purity test.
 - k. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.12 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems.

END OF SECTION 226113

SECTION 226213 - VACUUM PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Medical surgical vacuum piping and specialties designated "medical vacuum" operating at 15 inches mercury.
 - 2. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at 14 inches mercury.

1.3 DEFINITIONS

- A. D.I.S.S.: Diameter-index safety system.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. WAGD: Waste anesthetic gas disposal.
- D. Medical vacuum piping systems include medical vacuum and WAGD evacuation piping systems.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Vacuum and fittings.
 - 2. Vacuum valves and valve boxes.
 - 3. Medical vacuum service connections and vacuum-bottle brackets.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.

- G. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:

- 1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.

- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

- 1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

- C. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

- D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- F. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.

- G. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

1.6 COORDINATION

- A. Coordinate medical vacuum service connections with other service connections. Medical compressed-air service connections are specified in Division 22 Section "Compressed- Air Piping for Laboratory and Healthcare Facilities," and medical gas service connections.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.

- 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP- 73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.

1. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
3. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
4. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
 1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.
- B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - c. Allied- Chemetron
 2. Pressure Rating: 300 psig minimum.
 3. Ball: Full-port, chrome-plated brass.
 4. Seats: PTFE or TFE.
 5. Handle: Lever type with locking device.
 6. Stem: Blowout proof with PTFE or TFE seal.
 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Bronze Check Valves: In-line pattern.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - c. Allied - Chemetron
2. Pressure Rating: 300 psig minimum.
3. Operation: Spring loaded.
4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
2. Pressure Rating: 300 psig minimum.
3. Ball: Full-port, chrome-plated brass.
4. Seats: PTFE or TFE.
5. Handle: Lever type with locking device.
6. Stem: Blowout proof with PTFE or TFE seal.
7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
8. Vacuum Gage: Manufacturer installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
2. Interior Finish: Factory-applied white enamel.
3. Cover Plate: Satin-chrome finish steel with frangible or removable windows.

4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

G. Butterfly valves are not allowed.

2.4 MEDICAL VACUUM SERVICE CONNECTIONS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. Amico Corporation.
2. BeaconMedaes.
3. Allied - Chemetron

B. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:

- a. Steel outlet box for recessed mounting and concealed piping.
- b. Brass-body inlet block.
- c. Seals that will prevent vacuum leakage.
- d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:

- a. Brass housing with primary check valve.
- b. Seals that will prevent vacuum leakage.
- c. Cover plate with gas-service label.

3. D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

- a. Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.
- b. WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.

4. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.

5. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL VACUUM PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 1. Amico Corporation.
 2. BeaconMedaes.
- B. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 1. Vacuum Operating Range: 0- to 30-in. Hg.
- E. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
 1. Mounting: Recessed installation.
 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05- inch-thick aluminum, with knockouts for electrical and piping connections.
 3. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.
 4. Include alarm signals when the following conditions exist:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg and backup vacuum pump is in operation.
 - b. WAGD Evacuation: Vacuum drops below 12-in. Hg.
- F. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
 1. Include alarm signals when the following conditions exist:
 - a. Medical Vacuum: Vacuum drops below 12-in. Hg.
 - b. WAGD Evacuation: Vacuum drops below 12-in. Hg.
- G. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.

1. Include alarm signals when the following condition exists:

- a. Medical Vacuum: Vacuum drops below 12-in. Hg.

2.6 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Cast-Brass Escutcheons: With set screw.
 1. Finish: Polished chrome-plated.

2.7 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Medical Vacuum Piping: Use the following piping materials for each size range:
 1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- B. WAGD Evacuation Piping: Use the following piping materials for each size range:
 1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
- C. Drain Piping: Use the following piping materials:
 1. Copper water tube, cast- or wrought-copper fittings, and soldered joints.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with NFPA 99, ASSE Standard #6010 for installation of vacuum piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install vacuum and drain piping with 1 percent slope downward in direction of flow.
- H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
- I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- J. Provide drain leg and drain trap at end of each main and branch and at low points.
- K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator.
- L. Install piping to permit valve servicing.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
- O. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.
- P. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- Q. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- R. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

- S. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE APPLICATIONS

- A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from vacuum equipment and specialties.
- B. Butterfly valves shall not be used in the vacuum system.
- C. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
- D. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- E. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- F. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
- G. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.6 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

3.7 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION

- A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.
- B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.
- C. Install medical vacuum piping system area and master alarm panels where indicated.

3.8 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42 clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.

7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

- I. Install supports for vertical copper tubing every 10 feet.

3.10 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 1. Medical Vacuum: Black letters on white background.
 2. WAGD: White letters on violet background.

3.11 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

- A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of vacuum piping in nonmedical laboratory facilities.
- B. Tests and Inspections:
 1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - a. Test Pressure for Copper Tubing: 150 psig.
 2. Repair leaks and retest until no leaks exist.
 3. Inspect filters for proper operation.

C. Prepare test reports.

3.12 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.

B. Tests and Inspections:

1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for vacuum systems.
 - f. Repair leaks and retest until no leaks exist.
3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Final tie-in test.
 - g. Operational vacuum test.
 - h. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.

- C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.13 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 226213

SECTION 226313 - GAS PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Contract Drawings and Equipment Schedules for additional information, requirements, and details

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at 50 to 55 psig. Coordinate required pressure with equipment served and provide higher pressure manifold if required.
 - 2. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig.
 - 3. Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig.
 - 4. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. D.I.S.S.: Diameter-index safety system.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Medical gas piping systems include medical carbon dioxide, medical nitrogen, medical nitrous oxide and medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.
- E. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Tubes and fittings.
 - 2. Valves and valve boxes.
 - 3. Medical gas service connections.
 - 4. Patient service consoles.

5. Medical nitrogen pressure control panels.
 6. Ceiling columns. Include integral service connections.
 7. Ceiling hose assemblies. Include integral service connections.
 8. Medical gas alarm system components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For specialty and medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. NFPA Compliance:
1. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.
- F. UL Compliance:
1. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements.
- B. Coordinate medical gas service connections with other service connections. Medical-air service connections are specified.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
 - 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 - 2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP- 73, with dimensions for brazed joints.
 - 3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

2.3 VALVES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - c. Allied – Chemetron
 - d. Powerex Medical
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Handle: Lever type with locking device.
 - 6. Stem: Blowout proof with PTFE or TFE seal.
 - 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

- C. Check Valves: In-line pattern, bronze.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - c. Allied – Chemetron
 - d. Powerex Medical
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Operation: Spring loaded.
 - 4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - c. Allied – Chemetron
 - d. Powerex Medical
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Ball: Full-port, chrome-plated brass.
 - 4. Seats: PTFE or TFE.
 - 5. Handle: Lever type with locking device.
 - 6. Stem: Blowout proof with PTFE or TFE seal.
 - 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 - 8. Pressure Gage: Manufacturer-installed on one copper-tube extension.
- E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - c. Allied – Chemetron
 - d. Powerex Medical
 - 2. Interior Finish: Factory-applied white enamel.
 - 3. Cover Plate: Satin-chrome finish steel with frangible or removable windows.
 - 4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

- F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10- psig inlet pressure.

2.4 MEDICAL GAS SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
 - 3. Allied – Chemetron
 - 4. Powerex Medical
- B. General Requirements for Medical Gas Service Connections: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
 - c. Double seals that will prevent gas leakage.
 - d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
 - 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Double seals that will prevent gas leakage.
 - c. Cover plate with gas-service label.
 - 3. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - a. Medical Carbon Dioxide Service Connections: D.I.S.S. No. 1080.
 - b. Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
 - c. Medical Nitrous Oxide Service Connections: D.I.S.S. No. 1040.
 - d. Medical Oxygen Service Connections: D.I.S.S. No. 1240.
 - 4. Cover Plates: One-piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL NITROGEN PRESSURE CONTROL PANELS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
 - 3. Allied – Chemetron
 - 4. Powerex Medical
- B. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
 - 1. Minimum Working Pressure: 200 psig.
 - 2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
 - 3. Pressure Gages: 0- to 300-psig range.
 - 4. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
 - 5. Before final assembly, provide temporary dust shield and U-tube for testing.
 - 6. Label cover plate "Nitrogen Pressure Control."

2.6 MEDICAL GAS PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Amico Corporation.
 - 2. BeaconMedaes.
 - 3. Allied – Chemetron
 - 4. Powerex Medical
- B. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
- C. Components: Designed for continuous service and to operate on power supplied from 120V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- D. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 1. Low-Pressure Operating Range: 0- to 100-psig.
 - 2. High-Pressure Operating Range: Up to 250-psig.
- E. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. Mounting: Recessed installation.
 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05- inch- thick aluminum, with knockouts for electrical and piping connections.
- F. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.
1. Include alarm signals when the following conditions exist:
 - a. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.
 - b. Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig.
 - c. Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig.
 - d. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.
- G. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
1. Include alarm signals when the following conditions exist:
 - a. Oxygen: Pressure drops below 40 psig or rises above 60 psig.
- H. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
1. Include alarm signals when the following conditions exist:
 - a. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.
 - b. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

2.7 BUILDING CONTROL SYSTEM INTERFACE

- A. For each remote alarm provided at the alarm annunciator panel, provide a set of Form C dry contacts for remote monitoring at the Building Control System provided under Section 23 09 00 "Building Control System".
- B. In lieu of the dry contacts required in Paragraph A above, the manufacturer shall have the option of furnishing one of the following communications network interfaces to the Building Control System:
1. An industry standard open protocol communications network interface fully compatible with and interconnecting with the Building Control System communications network, based on one of the following network communications protocols:
 - a. BACNet TCP/IP– network communications shall use ASHRAE 135 protocol and communicate using ISO 802-3 (Ethernet) datalink/physical layer protocol;
 - b. BACNet MS/TP – network communications shall use ASHRAE 135 read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135, residing on network using MS/TP

- datalink/physical layer protocol and have service communication port for connection to the BCS; or,
- c. ModBus/TP – network communications shall use ModBus/TP over TCP/IP network.

- 2. Communications network hardware and firmware to allow communications with an IP address communicating directly over the Facility local area network complying with ISO 802-3 (Ethernet).

2.8 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
- B. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated.

2.9 NITROGEN

- A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

3.3 PIPING APPLICATIONS

- A. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

- B. Medical Nitrogen Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.4 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of medical gas piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
- L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
- M. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- N. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

- O. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install pressure regulators on gas piping where reduced pressure is required.
- F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.6 JOINT CONSTRUCTION

- A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- B. Braze Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

3.7 GAS SERVICE COMPONENT INSTALLATION

- A. Assemble patient service console with service connections. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.
- B. Install nitrogen pressure-control panels in walls. Attach to substrate.
- C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- D. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- E. Install gas manifolds on concrete base anchored to substrate.
- F. Install gas cylinders and connect to manifold piping.

3.8 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

- A. Install medical gas alarm system components in locations required by and according to NFPA 99.
- B. Install medical gas area and master alarm panels where indicated.

3.9 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.

3.10 HANGER AND SUPPORT INSTALLATION

- A. Vertical Piping: MSS Type 8 or 42, clamps.
- B. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer than 100 Feet: MSS Type 43, adjustable, roller hangers.
- C. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- D. Base of Vertical Piping: MSS Type 52, spring hangers.
- E. Support horizontal piping within 12 inches of each fitting and coupling.
- F. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4: 60 inches with 3/8-inch rod.
 - 2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
 - 3. NPS 3/4: 84 inches with 3/8-inch rod.
 - 4. NPS 1: 96 inches with 3/8-inch rod.
 - 5. NPS 1-1/4: 108 inches with 3/8-inch rod.
 - 6. NPS 1-1/2: 10 feet with 3/8-inch rod.
 - 7. NPS 2: 11 feet with 3/8-inch rod.
 - 8. NPS 2-1/2: 13 feet with 1/2-inch rod.

9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

3.11 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 1. Carbon Dioxide: Black or white letters on gray background.
 2. Nitrogen: White letters on black background.
 3. Nitrous Oxide: White letters on blue background.
 4. Oxygen: White letters on green background or green letters on white background.

3.12 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

- A. **Perform system field testing.**
- B. Testing Agency: Engage qualified testing agency to perform **field tests and** inspections of specialty gas piping for non-healthcare laboratory facilities and prepare test reports.
- C. Tests and Inspections:
 1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 2. Repair leaks and retest until no leaks exist.
 3. Inspect specialty gas regulators for proper operation.

3.13 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- A. **Perform system field testing.**
- B. Testing Agency: Engage a qualified testing agency to perform **tests and** inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- C. Tests and Inspections:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive pressure medical gas piping.
 - f. Standing pressure test for vacuum systems.
 - g. Repair leaks and retest until no leaks exist.
 3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical gas concentration test.
 - k. Medical air purity test.
 - l. Verify correct labeling of equipment and components.
 - m. Verify the following source equipment:
 - 1) Medical gas supply sources.
 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
- D. Remove and replace components that do not pass tests and inspections and retest as specified above.

END OF DOCUMENT 226313

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Adventist Health Preferred Partner List: All major vendors, manufacturers and equipment must be on the Adventist Preferred Partner List. All pricing shall be obtained from specific contact indicated on Adventist preferred partner list. In the event a facility standard product is not on the preferred partner list, permission must be obtained through Adventist Health System. Adventist preferred partner list shall overrule any manufacturers that may be listed in this written specification.
- B. Basic Requirements: Requirements of the Contract Forms, Conditions of the Contract, Specifications, Drawings, and Addenda and Contract Modifications (the Contract Documents), apply to the requirements of each Section of Division 23.
- C. Conflicts: Nothing contained in this Section shall be construed to conflict in any way with other provisions or requirements of the Contract documents. The intent is that this Section will take precedence. Where differences arise, the Architect shall decide which directions or instructions take precedence.

1.2 SUMMARY

- A. General: Unless an item is specifically mentioned as being provided by others, the requirements of Division 23 Contract Documents shall be completed. The systems, equipment, devices and accessories shall be installed, finished, tested and adjusted for continuous and proper operation. Any apparatus, material or device not shown on the Drawings but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the project complete and operational in all respects, shall be furnished, delivered and installed without additional expense to the Owner. Include all materials, equipment, supervision, operation, methods and labor for the fabrication, installation, start-up and tests necessary for complete and properly functioning systems.

1.3 APPLICABLE STANDARDS

- A. Code Compliance: Refer to Division 1. As a minimum, unless otherwise indicated, comply with all rules, regulations, standards, codes, ordinances and laws of local, state and federal governments and the amendments and interpretation of such rules, regulations, standards, codes, ordinances and laws of local, state and federal governments by the authorities having lawful jurisdiction.
- B. ADA: Comply with the requirements of the Americans with Disabilities Act (ADA).
- C. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.
- D. Maryland Building Code (2020): Conform in strict compliance to the Maryland Building Code (MBC) and the amendments which are enforced by the local authority having jurisdiction. This code modifies the 2018 IBC.

2. 2018 International Plumbing Code with amendments
 3. 2018 International Fuel Gas Code with amendments
 4. 2018 International Energy Conservation Code
 5. FGI - Guidelines for Design and Construction of Healthcare Facilities, 2018 Edition
- E. NATIONAL FIRE PROTECTION (NFPA) Standards:
1. NFPA-10, Standard for Portable Fire Extinguishers, 2018 Edition
 2. NFPA-11, Standard for Low Expansion Foam, 2016 Edition
 3. NFPA-13, Standard for the Installation of Sprinkler Systems, 2016 Edition
 4. NFPA-14, Standard for the Installation of Standpipe and Hose Systems, 2016 Edition
 5. NFPA-16, Standard for the Installation of Foam Water Sprinkler and Foam Water Spray Systems, 2015 Edition
 6. NFPA-17, Standard for Dry-Chemical Extinguishing Systems, 2017 Edition
 7. NFPA-20, Standard for the Installation of Stationary Pumps for Fire Protection, 2016 Edition
 8. NFPA-30, Flammable and Combustible Liquids Code, 2018 Edition
 9. NFPA-58, Standard for Storage and Handling of Liquefied Petroleum Gases, 2017 Edition
 10. NFPA-70, National Electrical Code, 2017 Edition
 11. NFPA-72, National Fire Alarm Code, 2016 Edition
 12. NFPA-99, Standard for Health Care Facilities, 2018 Edition
 13. NFPA-101, Life Safety Code, 2018 Edition
 14. NFPA-211, Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, 2016 Edition
 15. NFPA-704, Standard System for the Identification of the Fire Hazards of Materials for Emergency Response, 2017 Edition
 16. NFPA-2015, Standard on Clean Agent Fire Extinguishing Systems, 2012 Edition
- F. Notification: Comply with all of the requirements of the Federal "Right-To-Know" Regulations and the Maryland "Right-To-Know" Law and provide notification to all parties concerned as to the use of toxic substances.
- G. Owner Design Guidelines: Comply with all the requirements of the latest Owner MEP Engineering Design Guidelines and the latest Owner Architectural Construction Standards.

1.4 DRAWINGS AND SPECIFICATIONS

- A. Intent: The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
- B. Equipment Placement: The drawings are diagrammatic, intended to show general arrangement, capacity and location of various components, equipment and devices. Each location shall be determined by reference to the general building plans and by actual measurements in the building as built. Reasonable changes in locations ordered by the Architect prior to the performance of the affected Work shall be provided at no additional cost to the Owner.

- C. Drawing Scale: Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets, transitions and fittings may not be shown but shall be provided at no additional cost.
- D. Conflict: In the event of a conflict, the Architect will render an interpretation in accordance with the General Conditions.

1.5 DEFINITIONS

- A. Provide/Install: The word "provide" shall mean furnish, install, connect, test, complete, and leave ready for operation. The word "install" where used in conjunction with equipment furnished by the Owner or under another contract shall mean mount, connect, complete, and leave ready for operation.
- B. Concealed: The surface of insulated or non-insulated piping, ductwork or equipment is concealed from view when standing inside a finished room, such as inside a chase or above a ceiling.
- C. Exposed: The surface of insulated or non-insulated piping, ductwork or equipment is seen from inside a finished room, such as inside an equipment or air handling unit room.
- D. Protected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building but protected from direct exposure to rain by an overhang, eave, in an unconditioned parking garage or building crawl space.
- E. Unprotected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building and exposed to rain.
- F. Abbreviations: Abbreviations, where not defined in the Contract Documents, shall be interpreted to mean the normal construction industry terminology, as determined by the Architect. Plural words shall be interpreted as singular and singular words shall be interpreted as plural where applicable for context of the Contract Documents.

1.6 SHOP DRAWINGS

- A. General: Refer to paragraph entitled "SUBMITTAL" in this section. Include the following data:
 - 1. Shop Drawings:
 - a. Submit shop drawings for the following:
 - (1) Each Piping System
 - (2) Ductwork Systems as Specified
 - (3) Coordination Drawings (3D Drawings Coordinating with all disciplines: HVAC Sheet Metal; HVAC Piping, Plumbing Domestic Water Piping; Plumbing Medical Gas Piping; Fire Sprinkler Piping; Electrical; Technology; Plumbing Sanitary and Roof Drain Piping, Pneumatic Tube Drawings etc)

1.7 RECORD DRAWINGS

- A. Production: Maintain one set of black or blue line on white project record "as-built" drawings at the site. At all times the set shall be accurate, clear, and complete, indicating the actual installation. Record drawings shall be updated weekly to record the present stage of progress. These drawings shall be available to the Architect at all times. Equipment schedules, control diagrams, sequences of operation shall also be updated.
- B. Completion: Prior to substantial completion, transfer onto an unmarked second set of drawings all changes, marked in colored pencil, and submit them to the Architect. Upon completion of all punch lists, transfer all "As-Built" conditions to the contractors Revit Model, package three (3) print sets of full-size drawings and the latest updated construction Revit Model with associated families and submit them to the Architect for review and approval.

1.8 SUBMITTAL

- A. General: The provisions of this section are supplemental to the requirements in Division 1, and only apply to the material and equipment covered in Division 23.
- B. Time: Submit manufacturer's literature, performance data and installation instructions covered in each Section of Division 23 under an individual letter of transmittal within 30 days after Notice to Proceed unless otherwise indicated.
- C. Submitter's Review: All items required for each section shall be reviewed before submittal. Submittal information for each item shall bear a review stamp of approval, indicating the name of the Contractor and Subcontractor (where applicable), the material suppliers, the initials of submitter and date checked. Responsibility for errors or omissions in submittals shall not be relieved by the Architect's review of submittals. Responsibility for submittals cannot be subrogated to material suppliers by Contractors or Subcontractors.
 - 1. Review of the submittal data, whether indicated with "APPROVED" or with review comments, does not constitute authorization for or acceptance of a change in the contract price.
- D. Architect's Review: The submittal data shall be reviewed only for general conformance with the design concept of the project and for general compliance with the Contract Documents. Any action indicated is subject to the requirements of the Contract Documents. Reviews of submittal data review shall not include quantities; dimensions (which shall be confirmed and correlated at the job site); fabrication processes; techniques of construction; and co-ordination of the submittal data with all other trades. Copies of the submittal data will be returned marked "ACCEPTED AS SUBMITTED", "ACCEPTED AS NOTED", "REVISED AS NOTED AND RESUBMIT", "REJECTED, REVISED AS NOTED AND RESUBMIT".
- E. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right-hand corner of each item. All typewritten pages shall be on the product or equipment manufacturer's printed letterhead.
 - 1. Manufacturer's Literature: Where indicated, include the manufacturer's printed literature. Literature shall be clearly marked to indicate the item intended for use.

2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.
3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.
4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of product, they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment, they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".

F. Substitutions:

1. General: Refer to Division 1. Substitutions may be considered for any product or equipment of a manufacturer. See paragraph entitled "MANUFACTURER" in this Section. Any product or equipment may be submitted for review; however, only one substitution per item will be considered. If a substituted product or equipment item is rejected, provide the specified product or equipment.
 - a. Submittal shall include the name of the material or equipment to be substituted, equipment model numbers, drawings, catalog cuts, performance and test data and any other data or information necessary for the Architect to determine that the equipment meets the specification requirements. If the Architect accepts any proposed substitutions, such acceptance will be set forth in writing.
 - b. Substituted equipment with all accessories installed or optional equipment where permitted and found acceptable, must conform to space requirements. Substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at no additional expense to the Owner. If the substituted item affects the work of other trades, the Request for Substitution form shall include a list of the necessary modifications.
2. Deviations: The Request for Substitution form shall include a complete list of deviations from the scheduled item stating both the features and functions of the scheduled item and the comparable features and functions of the proposed substitution.

- a. Any deviation not indicated in writing will be assumed to be identical to the specified item even if it is shown otherwise on the submittal data.
 - b. If a deviation not listed is found any time after review and acceptance by the Architect and that deviation, in the opinion of the Architect, renders the substituted item as unacceptable, the item shall be removed and replaced by the scheduled item at no additional cost to the Owner.
 - c. The Architect shall retain the right to specify modifications to the substituted item, correcting or adjusting for the deviation, if the Architect deems it to be in the best interest of the Owner.
3. **Scheduled Item:** A scheduled item is a product or item of equipment indicated in the Contract Documents by manufacturer's name and model number identifying a single item. The manufacturer's trade name for a group of products that does not signify a single item including type, style, quality, performance, and sound rating shall not be classified as a scheduled item. Where more than one manufacturer and product model number are indicated, each shall be considered as a scheduled item.
4. **Form:** When a product or item of equipment is proposed as a substitution a "REQUEST FOR SUBSTITUTION" form shall be completed and submitted with the required data. A copy of the form is included after the end of this section.
5. **Rejection:** Substituted products or equipment will be rejected if, in the opinion of the Architect, the submittal does not meet any one of the following conditions or requirements:
 - a. The submittal data is insufficient or not clearly identified. The Architect may or may not request additional information.
 - b. The product or equipment will not fit the space available and still provide the manufacturers published service area requirements.
 - c. The product or equipment submitted is not equivalent to or better than the specified item. Products or equipment of lesser quality may be considered provided an equitable financial rebate, satisfactory to the Architect, is to be returned to the Owner.
 - d. The product or equipment submitted has less capacity, efficiency and safety provisions than the specified item.
 - e. The product or equipment submitted does not have warranty, service and factory representation equivalent to that specified.
 - f. The Owner prefers not to accept the submitted product.

G. **Technical Information Brochure:**

1. **Binder:** Include binders with the first submittal for the Technical Information Brochure. Each binder shall be size 3-inch, hardcover, 3-ring type for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on spine of each binder, i.e., MECHANICAL SUBMITTAL DATA, MECHANICAL OPERATION INSTRUCTION and MECHANICAL MAINTENANCE INSTRUCTIONS.
2. **Number:** Submit not less than five sets of binders for each of the three mechanical brochures indicated above. Each set shall consist of a minimum of two binders for submittal data and 1 binder each for operating instructions and for maintenance instructions. Additional binders shall be submitted at the request of the Architect. One set of binders shall be retained by the Architect. Three sets of binders shall be maintained for the Owner and the remaining set shall become the property of the Engineer.

3. Index: First sheet in each brochure shall be a photocopy of the "Division 23 Index" of the specifications. Second sheet shall list the firm name, address, phone number, superintendent's name for the contractor and all major subcontractors and suppliers associated with the project.
4. Dividers: Provide reinforced separation sheets tabbed with the appropriate specifications Section reference number for each Section in which submittal data or operation and maintenance instructions is required.
5. Specifications: Insert a copy of the specifications for each Section and all addenda applicable to the Section between each of the Section dividers.

1.9 SHOP DRAWINGS FOR PIPING SYSTEMS

- A. Requirements: Make Shop Drawings for piping systems at a minimum scale of 1/4 inch per foot in Revit and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
 1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
 2. Fabrication and erection dimensions.
 3. Arrangements and sectional views.
 4. Necessary details, including complete information for making connections to equipment.
 5. Descriptive names of equipment.
 6. Modifications and options to standard equipment required by Contract Documents.
- B. Stamp Area: Leave 4 inch by 2-1/2-inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and equipment connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- D. Additional Requirements: See specific Sections for additional requirements.

1.10 SHOP DRAWINGS FOR DUCT SYSTEMS

- A. Requirements: Make Shop Drawings for duct systems at a minimum scale of 1/4 inch per foot in Revit and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
 1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
 2. Fabrication and erection dimensions.
 3. Arrangements and sectional views.

4. Necessary details, including complete information for making connections to air distribution devices and air handling equipment.
 5. Kinds of materials and finishes.
 6. Descriptive names of equipment.
 7. Modifications and options to standard equipment required.
- B. Stamp Area: Leave 4 inch by 2-1/2-inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- D. Ceiling Plans: Provide Shop Drawings, using architectural reflected ceiling plans, which indicate locations of exposed air distribution devices, sprinkler heads, lights and access panel.
- E. Additional Requirements: See specific Sections for additional requirements.

1.11 COORDINATION DRAWINGS

- A. General: Provide detailed (minimum 1/4 inch per foot) scaled coordination drawings showing locations and positions of all architectural, structural, (FF&E) equipment, electrical, plumbing, fire protection and mechanical elements for all installations. Provide overlay drawings, prior to beginning work, indicating work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions and other services. Accommodate phasing and temporary conditions indicated on the contract drawings as necessary to complete the work without disruption to the Owner's use of the existing occupied areas of the building(s).
- B. Coordination of Space: Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- C. In finished areas except as otherwise shown, conceal pipes, ducts, and wiring in construction. Coordinate locations of fixtures and outlets with finish elements. Contractor shall provide background drawings showing partitions, ceiling heights, and structural framing locations and elevations, and existing obstructions. Contractor shall resolve major interferences at initial coordination meeting prior to production of coordination drawings.
- D. Precedence of Services: In event of conflicts and interferences involving location and layout of work, use the following priority to resolve interferences:
1. Structure has highest priority.
 2. Walls systems.
 3. Ceiling grid/light fixtures.
 4. Gravity drainage lines.

5. Large pipe mains.
 6. Ductwork/diffusers, registers and grilles.
 7. Sprinkler heads.
 8. Small piping and tubing/electrical conduit.
 9. Access panels.
- E. Drawings shall be developed on Revit and utilize AIA Standard model conventions. At the completion of the project construction, the Contractor shall provide two (2) full-sized print sets of all drawing files with related reference files representing as-built installations for Architect review. Upon approval that the submitted information is complete, a similar submittal shall be provided to the Owner.
- F. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- G. Additional Requirements: See specific Sections for additional requirements.

1.12 MANUFACTURER'S CHECKOUT

- A. Start-up and Checkout: At completion of installation and prior to performance verification, a factory-trained representative of the manufacturer shall provide start-up and checkout service. After the performance verification the manufacturer's representative shall examine performance information and check the equipment in operation, and sign "Check-Out Memo" for the record. Submit a copy of Memo on each item of equipment where indicated in individual sections of these specifications for inclusion in each Technical Information Brochure. The "Check-Out Memo" shall be included with the performance verification data. Do not request "Instruction in Operation Conference" or request final inspection until Memos have been submitted and found acceptable.

1.13 INSTRUCTION TO OWNER

- A. General: Instructions to the Owner shall be by competent representatives of the manufacturers involved, with time allowed for complete coverage of all operating procedures. Provide classroom instruction and field training in the design, operation and maintenance of the equipment and troubleshooting procedures. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar provisions of the systems. On the date of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.
- B. Training Period: Unless otherwise indicated training periods shall encompass the following number of hours of classroom and hands-on instructions with a maximum period of 4 hours per day for either. Mixing classroom instructions and hands on training in the same day is unacceptable.
1. Training Periods:
 - a. 8 hours Classroom
 - b. 4 hours Hands-on
- C. Scheduling: Submit any remaining required items for checking at least one week before final inspection of building. When submittal items are found acceptable, notify Owner, in writing, that an "Instruction in Operation Conference" may proceed. Conference will

be scheduled by the Owner. After the conference, copies of a memo certifying that the "Instruction in Operation Conference" and "Completed Demonstration" have been made will be signed by Owner and the instructors, and one copy will be inserted in each Technical Information Brochure.

1.14 ALLOWANCES

- A. General: Division 1.

1.15 ALTERNATES

- A. Refer to Division 1.

1.16 STRUCTURAL CALCULATIONS FOR ROOF-MOUNTED EQUIPMENT

- A. All roof-mounted devices, equipment and systems shall be constructed, designed and fastened to withstand wind loads of velocities up to 155 mph. Structural calculations for roof-mounted equipment shall be completed in accordance with Maryland Building Code requirements and submitted by a structural engineer registered in the State of Maryland. Mechanical/general contractor shall engage a structural engineer and provide a submittal for all tie-downs/supports for exhaust fans, piping supports, roof top units, condensing units and ductwork. Fastening systems shall be designed to meet the wind load requirements of MBC, Building and they and all associated equipment shall be protected as required by TAS 201, 202 and 203 in accordance with the requirements of M
- B. BC from damage by horizontal impact by a separate and independent structure that allows access to all parts of the equipment at all time or are completely protected by the equipment shrouding that meets the requirements of TAS 201, 202 and 203 in accordance with the requirements of the MBC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specified Products: Manufacturer's names and product model numbers indicated on the drawings and in these specifications establish the type, style, quality, performance, and sound rating of the desired product. Listing of other manufacturers indicates that their equivalent products would be acceptable if they meet the specification requirements, the specific use and installation shown on the drawings, including space and clearance requirements, and the energy consumption and efficiency of the specified product. The listing of additional manufacturers in no way indicates that the manufacturer can provide an acceptable product.
- B. Space Requirements: All manufactured products furnished on this project must have the required space and service areas indicated in the manufacturer's printed literature or shown on their shop drawing. When the manufacturer does not indicate the space required for servicing the equipment, the space shown on the drawings or as required by the Architect must be provided.

2.2 MATERIAL AND EQUIPMENT

- A. General: Material and equipment used shall be produced by manufacturers regularly engaged in the production of similar items, and with a history of satisfactory use as judged by the Architect.

- B. Specified Equipment: Equipment shall be the capacity and types indicated or shall be equivalent in the opinion of the Architect. Material and equipment furnished and installed shall be new, recently manufactured, of standard first grade quality and designed for the specific purpose. Equipment and material furnished shall be the manufacturer's standard item of production unless specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution. Ratings and capacities shall be certified by a recognized rating bureau. Products shall be complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.
- C. Compatibility: Material and equipment of one and the same kind, type or classification and used for identical or similar purposes shall be made by the same manufacturer. Where more than one choice is available, select the options which are compatible with other products already selected. Compatibility is a basic general requirement of product selection.
- D. Coordination of Materials: In the event of multiple award packages for the completion of this work, the Contractor shall direct and lead the coordination effort necessary to ensure that all materials and equipment that have moving parts, are procured from the same manufacturer and are the same model as consistent with its use and as required by these specifications.
 - 1. The Contractor shall additionally ensure that the installation of this material and equipment is consistent for the Owner's use and maintenance and shall affect necessary adjustments to render the installations consistent.
 - 2. In the event of dispute, the earlier award package materials, as prescribed by approved submittal documents, shall take precedent in defining the material and equipment coordination requirements of the project.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be done in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a first-quality installation. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks. All materials and equipment shall be installed per the manufacturer's written requirements.
- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function which conforms to applicable standards of building system construction and exhibits a degree of quality and proficiency which is judged by the Architect equivalent as or better than that ordinarily produced by qualified industry tradesmen.
- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment that, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents or installed with substandard workmanship in

the opinion of the Architect, shall be removed and reinstalled by qualified craftsmen at no change in the contract price.

3.2 AIR CONVEYANCE SYSTEM MECHANICAL CLEANING (New Duct Installation)

- A. General: The following criteria shall be used for the installation of all new HVAC air conveyance systems (ACS).
- B. Qualifications: The enhanced air conveyance system cleaning procedures shall be performed by the Contractor. Microbiological analysis shall be performed by a firm which is acceptable to the Architect, and which can demonstrate their ability to conduct the required analysis and reporting according to the NADCA and National Institute for Occupational Safety and Health (NIOSH) Methods. Submit for review and acceptance by the Architect the proposed procedure methodologies to be utilized, a listing of the proposed equipment to be used, and the proposed chemical agents to be used.
- C. Cleaning Procedure: All ductwork transported to the project shall be protected from weather and debris. Once on site, all ductwork shall be stored via an elevated structure above a finished floor slab and covered with plastic to protect from construction debris. Each HVAC duct section shall, prior to installation, be cleaned and disinfected. Exhaust ductwork shall only require surface preparation from Note 1 below. All air distribution devices (diffusers, grilles, register) including back pans of supply devices in critical areas, as defined by AIA, shall be decontaminated pursuant to Note 3 below. Four stages of ACS cleaning shall occur:
 - 1. Surface dirt shall be removed by mechanical means, HEPA filtered vacuum and washed down with disposable cleaning cloths and 1:200 solution of trisodium phosphate (TSP) detergent.
 - 2. Wipe down surface with TSP solution again, frequently disposing contaminated cloths.
 - 3. Decontaminate duct section with a diluted solution (4-6 tablespoons per gallon or as directed by manufacturer for use) of chlorhexidine diacetate, similar to Aveco Company Nolvasan, for an appropriate contact period then wipe down and rinse with clean cloths per the application processes defined by manufacturer guidelines.
 - 4. Cap ducts with a 6 mil. plastic fastened completely to duct openings.
- D. Sterilization, Occupied Facility: After the ACS has been cleaned and installed, provide surface sampling shall be performed by firm to confirm absence of *Aspergillus fumigatus*. Upon installation of a zone, the entire ACS shall then be flooded with Bioclean, or another low-odor dual quaternary ammonium compound, EPA registered for use in HVAC systems, and acceptable to the Architect, to sterilize the ACS. The ACS shall be tested in compliance with NADCA Level III sampling protocol until all air samples indicate a colony forming unit (CFU) count of 1.0 CFU per cubic meter or less; re-clean, re-sterilize and retest until all samples achieve results at or below this threshold level.
- E. Reporting: Provide a complete report detailing the above processes. The report shall contain, as a minimum, the procedure methodologies utilized; the listing of the equipment used; a description of the portions of the ACS which were treated; the chemical agents which were used; the test results from the analysis.

3.3 CLEANING AND PROTECTION

- A. General: Refer to Division 1.

- B. Emergency Contacts: Prior to the beginning of the project, provide the Owner with a list of names, emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period if leaks, equipment failure or other damages occur. Update the list throughout installation and warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may affect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- C. Emergency Contacts: Along with the operating and maintenance manual submittal, provide the Owner with a list of the names and emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period should leaks, equipment failure or other damage occur. Update the list throughout warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may affect emergency repairs through other means and may back charge for the costs of repair material and labor incurred.
- D. Housekeeping: Keep interiors of duct and pipe systems clean and free from dirt, rubbish and foreign matter. Close open ends of piping and ductwork at all times throughout the installation. Install 30% efficient filter media over each return air grille and open return duct opening; change media regularly during construction when dirty to keep duct interiors clean. Prevent dust, debris and foreign material from entering the piping and ductwork.
- E. Equipment Protection: Protect fan motors, switches, equipment, fixtures, and other items from dirt, rubbish and foreign matter. Do not operate air-handling equipment if the building is not clean or if dust can enter the coils or the fan housings.
- F. Equipment Cleaning: Thoroughly clean equipment and entire piping systems internally upon completion of installation and immediately prior to final acceptance. Open dirt pockets and strainers, blow down each piping system and clean strainer screens of accumulated debris. Remove accumulated dirt, scale, oil and foreign substances. Thoroughly wipe clean internal surfaces of ductwork and air handling units prior to request for substantial completion. (See para. 3.2 above.)
- G. Building Cleanup: Remove debris, rubbish, leftover materials, tools and equipment from work areas and site. Clean tunnels and closed off spaces of packing boxes, wood frame members and other waste materials used in the installation. Final acceptance shall not be approved until site is cleaned.
- H. Fixture Cleanup: Remove temporary labels, stickers, etc., from fixtures and equipment. Do not remove permanent nameplates, equipment model numbers, ratings, etc.
- I. Filter Replacement: Provide filters, with the same efficiency rating as required for the final installation, for the protection of the air moving equipment and ductwork continuously throughout the construction phase. Provide a new set of clean filters for the test and balance of the air side equipment.
- J. Protection of Finished Installation: Where installation is required in areas previously finished by other trades, protect the area from marring, soiling or other damage.

- K. Air Handling Unit Operation During Construction Phase: Do not operate air handling equipment during building construction phase unless filter fabric is fastened to all duct systems' inlets and all specified and scheduled air filters are installed to minimize dirt entry into ductwork and air moving equipment. When running air handling units to dry out the building, control the building temperature to drop very slowly, and verify all HVAC insulation is completed and doors and windows are installed and closed, to prevent condensation of water from humid air on building interior surfaces, equipment, materials and ductwork.

3.4 CORRECTION OF WORK

- A. General: At no additional cost to the Owner, rectify discrepancies between the actual installation and contract documents when in the opinion of the T&B Agency or the Architect the discrepancies will affect system balance and performance.
- B. Drive Changes: Include the cost of all pulley, belt, and drive changes, as well as balancing dampers, valves and fittings, and access panels to achieve proper system balance recommended by the T&B Agency.

3.5 COORDINATION AND ASSISTANCE

- A. General: Provide all labor, equipment, tools and material required to operate the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.
- B. Drawings and Specifications: Provide to the T&B Agency a complete set of project record drawings and specifications and an approved copy of all HVAC shop drawings and equipment submittals. The T&B Agency shall be informed of all changes made to the system during construction, including applicable change orders.
- C. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the T&B Agency and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

3.6 PREPARATIONS FOR PERFORMANCE VERIFICATION

- A. Verification: Prior to commencement of the balancing by the T&B Agency, the Contractor shall verify in writing:
 - 1. That air filters have been replaced and are in clean condition.
 - 2. That linkages between dampers and their actuators are secure, non-overloading and non-binding.
 - 3. That ductwork specialties are in their normal operating positions.
 - 4. That fans are operating at the correct rotation and specified RPM.
 - 5. That ductwork has been pressure tested and accepted.

6. That strainers have been removed, cleaned and replaced, and that temporary construction strainers have been removed.
7. That compression or expansion tanks have been inspected, are not air-bound or water-logged and are pre-charged, and that the piping systems have been completely vented and filled with water.
8. That air vents at coils and high points of the piping systems have been inspected and installed and operating freely.
9. That automatic valves, hand valves, and balancing valves have been placed in a fixed open position for full flow through all devices.
10. That linkages between valves and their actuators are secure, non-overloading and non-binding.
11. That pressures for hydronic reducing valves have been set.
12. That operating temperatures have been set for chillers, regulating valves, etc.
13. That pumps are operating at the correct rotation and specified horsepower.
14. That piping has been pressure tested and accepted and piping systems have been cleaned, flushed, sterilized and refilled with chemicals and prescribed treated water and vented.
15. That operating temperatures have been set for boilers, regulating valves, etc.
16. That the operating safeties (thermal overloads, firestat/freezestats, smoke detectors, relief valves, etc.), are installed and fully functional.
17. That equipment has been lubricated and can be operated without damage.
18. That the systems are operational and complete.
19. That no latent residual work remains to be completed.

3.7 ACCEPTANCE TESTING PROCEDURE

- A. General: Each HVAC system shall be tested to confirm proper operation and function in accordance with the construction documents and control sequence of operations.
- B. The enclosed checklists shall be completed for each system and signed off by the mechanical sub-contractor project representative, then verified and signed-off by the mechanical sub-contractor project supervisor and the construction manager systems engineer. All checklists shall be incorporated into the project's close-out manuals submitted for Owner record.
- C. On-site testing by the Architect and Engineer shall be performed at the discretion of the Architect/Engineer for any or all systems to confirm test results and system function.

- D. The Contractor is responsible to provide adequate time in the completion of the construction to perform these system tests prior to the building final inspections in the affected areas/systems.
- E. The Contractor is responsible for ensuring all required system tests are conducted successfully and recording associated test data and results.
- F. The Contractor is responsible for contacting the Architect and Engineer at least two weeks prior to system test availability and schedule acceptable to Architect/Engineer for on-site testing.
- G. If, in the Architect's and Engineer's opinion, the test results indicate that the systems' installation is not adequately complete for testing, the testing shall be re-scheduled, and the Contractor shall be responsible to prepare for such re-test.
- H. Prior to Owner occupancy, all system testing shall be completed and approved.

3.8 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been "dried in". If dry space is unavailable and the insulation and equipment must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.
- B. Replacement of Damaged Stored Material and Equipment: Any material and equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be replaced with new material regardless of the condition of the material and equipment at the time of installation.
- C. Repair of Damaged Installed Material and Equipment: After installation correct or repair dents, scratches and other visible blemishes. At the direction of Architect replace or repair to "as new" condition equipment which has been damaged during construction.
- D. During construction, all piping and ductwork system openings shall be capped with at least two layers of polyethylene film, fastened tightly in place with banding material or foil tape until connection of the continuation of such piping or ductwork is occurring.
- E. All air diffusers serving critical care areas shall be disinfected per owner infection control guidelines with a commercial germicide complying with EPA regulations utilizing per manufacturer use standards prior to building occupancy.

3.9 COORDINATION OF SERVICES

- A. General: Where phasing of the work requires partial occupancy, coordinate interruption of services to Owner-occupied areas in writing in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.
- B. General: Coordinate interruption of services in writing at least 1 week in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.

- C. Protection of Facilities: Portions of the building may be operational during construction. Maintain operation of the equipment and systems whenever the installation interfaces with equipment or systems. Provide protection for the building, its contents and occupants wherever installation under the contract is performed. As necessary, move, store, and protect furniture, office fixtures and carpets. Provide acoustical isolation of the work area with temporary doors, partitions, etc., to allow normal work functions. Provide exhaust fans, temporary dust barrier partitions and any containment measures required to prevent dirt, dust or fumes from reaching adjacent occupied spaces as required by the Owner or Architect. Access to the building, including exit stairs, doors and passageways, and loading dock and other delivery areas shall be kept open and continuously accessible to the occupants. Workmen shall be confined to those areas directly involved in the project installation, and only during time periods indicated and approved by the Owner.

3.11 PAINTING OF PIPING AND DUCTWORK

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual".
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting of Fire Protection work:
 - 1. Paint the following work where exposed in Equipment Rooms:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Tanks that do not have factory applied final finishes.
 - e. Duct, equipment and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

- 2. Paint the following work where exposed in Occupied Spaces:

- Equipment, including panelboards.
- Uninsulated metal piping.
- Uninsulated plastic piping.
- Pipe hangers and supports.
- Duct, equipment and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.12 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
- B. Contractor shall touch up and restore painted surfaces damaged by testing.
- C. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.13 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION 230100

ACCEPTANCE TESTING CHECKLIST		
AIR HANDLING UNIT # _____	OK	N/A
FANS AND CASING SECTIONS:		
1. Spring isolators installed and not bottomed out.		
2. Motor rotation correct and free fan wheel rotation.		
3. Motor belts aligned and properly tensioned.		
4. Proper starter/VFD installed and labeled.		
5. Bearing races secured tight to fan shaft.		
6. Bearing grease cert fitting accessible and lubricated.		
7. All bolts, fasteners, and set screws checked & tightened.		
8. At full speed, fans have no unusual noise or vibration.		
9. All safety guards are properly installed.		
10. Access doors close tightly, door gaskets installed.		
11. Casing/duct sealed with proper sealant.		
12. Proper insulation installed on casing and duct, and joints sealed.		
13. No evidence of air escaping unit or insulation ballooning w/fans on.		
14. No evidence of negative machine room pressure with fans operating.		
15. Fan air volume measuring device installed.		
16. Duct static pressure control sensor installed at proper location.		
17. Duct safety static pressure sensor installed at proper location.		
18. Flex connection at fan discharge installed.		
19. Condensate drain trapped properly and run to floor drain.		
20. Manufacturer's required clearances for unit/components maintained.		
21. Dampers/actuators properly installed & close tightly.		
22. Damper linkage checked for binding, min. play & right blades.		
23. Required maintenance clearances maintained.		
24. Filters installed tightly and checked for no bypass.		
25. Metal spacers installed in filter rack.		
26. Filter manometers installed and calibrated.		
27. Air Handler control system operational.		
CHILLED WATER COILS:		
1. Coils clean and fins in good condition.		
2. No open area around coil for air bypass.		
3. Coil piped for counter flow.		
4. Chilled water pipe complete and piping properly supported.		
5. Chilled water pipe is properly insulated and labeled.		
6. Chilled water pipe pressure test complete and no leaks.		
5. Air bleed valves with caps installed.		
6. Strainers, drain valve, hose bib and cap installed.		
7. Dirt leg drain valve w/hose bib connections & caps installed.		
8. Piping, valves, and clearances accommodate coil removal.		
9. Balance valve properly installed.		

10. Control valves properly installed.		
11. Pilot positioner installed on control valve actuator.		
11. Thermometers, PT plugs, pressure gages properly installed.		
12. Condensate pan, drain, and trap drains condensate properly.		
HEATING HOT WATER COILS:		
1. Coils clean and fins in good condition.		
2. Hot water pipe is complete and properly supported.		
3. Thermometers, PT plugs, pressure gages properly installed.		
4. Control valve installed if coil is w/o integral face & bypass dampers		
5. Two position valve installed if coil has integral face & bypass dampers		
6. Piping, valves, and clearances accommodate coil removal.		
7. Local in-line coil circulating pump installed & operable.		
8. Strainer, drain valve, hose bib and cap installed.		
9. Air bleed valves with caps installed.		

Air Handling Unit Comments:

Approvals:

Date _____
Mech. Contractor Signature

Date _____
GC PM/Sys. Engineer Signature

CHILLER # _____	OK	N/A
1. Isolation valves installed.		
2. Pipes properly supported & not supported by chiller.		
3. Refrigerant relief vented outside and rain protected.		
4. Relief piping weight not bearing on rupture disc.		
5. Adequate space for tube pull.		
6. Unit has proper insulation type and thickness.		
7. Piping and insulation is complete and undamaged.		
8. Flow direction is indicated correctly on chilled and condenser water lines.		
9. Insulation is installed where condensation may occur.		
10. Pressure gages are installed across evaporator and condenser.		
11. Thermometers are installed across evaporator and condenser.		
12. Evaporator and condenser heads removed, inspected, & trash free.		
13. Vibration isolation pads installed.		
14. Differential pressure type flow switches are installed.		
15. Drain valves piped to floor drain.		
16. Control wells installed.		
17. Oil cooler piped.		
18. Clearances have been maintained and piping is installed for service.		
19. Chilled and Condenser water connections to chiller are correct.		
20. Chilled & condenser pumps are interlocked to chiller in auto mode.		
21. CT fans enabled when chiller is in auto mode.		
22. Factory representative start-up completed and documented.		
23. PT plugs are installed at entering & leaving evap & cond connections.		

Chiller Comments:

Approvals:

Date _____
Mech. Contractor Signature

Date _____
GC PM/Sys. Engineer Signature

CV TERMINAL BOX # _____	OK	N/A
1. At least 1 & 1/2 box inlet diameter of hard duct attached to box inlet.		
2. Run out from lateral is the correct size.		
3. Required clearance for servicing box.		
4. Correct piping package for reheat coil.		
5. Hot water return off top of coil.		
6. Electrical connections complete.		
7. Box properly located and supported.		

Terminal Box Comments: _____

Approvals:

 Mech. Contractor Signature

Date _____

 GC PM/Sys. Engineer Signature

Date _____

___CHW ___CW ___HHW PUMP # _____	OK	N/A
1. Pressure gauge connection at pump inlet & outlet flanges.		
2. Single pressure gauge installed with cocks to select in or our pressure.		
3. Rotation correct.		
4. Strainer w/valve, hose bib and cap installed.		
5. Piping supported so that pump bears no pipe weight or lateral force.		
6. Drains piped to floor drain.		
7. Motor and pump coupling alignment verified.		
8. Cleanout of system piping complete.		
9. Suction diffuser start up strainer has been replaced w/ permanent strainer.		
10. Pumps properly grouted.		
11. Expansion tank connected to suction side of pump.		
12. Makeup water PRV set at correct pressure.		
13. VFD's installed.		

Pump Comments: _____

Approvals:

 Mech. Contractor Signature

 GC PM/Sys. Engineer Signature

REQUEST FOR SUBSTITUTION

Project Name: _____ Location: _____

Date of Request: _____

Name of Party Requesting Substitute:

Reason for Substitution Request:

Drawing	Spec. Sect. No.	Paragraph	Specified Item
_____	_____	_____	_____

Proposed Substitute: _____

Manufacturer and Model Number:

Deviations from the Specified Item: (See paragraph entitled "Deviations".)

Reason for Substitution:

Changes to Other Systems to Permit Use of Proposed Substitute:
(List changes. Submit drawings if required for clarity.)

Technical Data to Support Request for Acceptance:
(List ASTM or other standards designations, testing laboratory reports, experience records, etc.)

Other Supporting Data:
(Submit brochures, samples, drawings, etc.)

Certification: In making request for substitution, the party whose authorized signature appears below, certifies that all of the following statements are correct and are accepted without exception:

The proposed substitution has been personally investigated and is equal or superior in all significant respects to the product specified for the specific applications required;

The proposed substitution will be warranted under the same terms required for the specified product;

Coordination aspects necessitated by the proposed substitution will be accomplished in a complete and proper fashion by the party signing this form without any additional cost to the Owner; and

Claims against the Owner for additional costs related to the proposed substitution which subsequently become apparent after acceptance by the Architect are hereby waived.

Credit: If this substitution is acceptable the following credit shall be given to the Owner;

\$ _____

CERTIFICATION OF EQUIVALENT PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUIVALENT PERFORMANCE

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by: _____
Signature Title

Typed Name: _____

Company:

Signature shall be by person having authority to legally bind his firm to the above terms. Failure to provide a legally binding signature will invalidate this request.

SECTION 230130 - HVAC AIR DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

1.3 DEFINITIONS

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For an ASCS.
- B. Strategies and procedures plan.
- C. Cleanliness verification report.

1.5 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
 - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
 - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.
- C. Cleaning Conference: Conduct conference at project site.
 - 1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.

- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
 - 1. Supervisor contact information.
 - 2. Work schedule including location, times, and impact on occupied areas.
 - 3. Methods and materials planned for each HVAC component type.
 - 4. Required support from other trades.
 - 5. Equipment and material storage requirements.
 - 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.
- D. Coordinate with general contractor for cleaning to be complete prior to final Test and Balance.

3.3 CLEANING

- A. Comply with NADCA ACR 2006.
- B. Remove visible surface contaminants and deposits from within the HVAC system.
- C. Systems and Components to Be Cleaned:
 - 1. Air devices for supply and return air.
 - 2. Air-terminal units.
 - 3. Ductwork:
 - a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
 - b. Return-air ducts to the air-handling unit.
 - c. Exhaust-air ducts.
 - 4. Air-Handling Units:
 - a. Interior surfaces of the unit casing.
 - b. Coil surfaces compartment.
 - c. Condensate drain pans.
 - d. Fans, fan blades, and fan housings.
 - 5. Filters and filter housings.

- D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- E. Particulate Collection:
 - 1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
 - 2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- F. Control odors and mist vapors during the cleaning and restoration process.
- G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- I. Clean all air-distribution devices, registers, grilles, and diffusers.
- J. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:
 - 1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
 - 2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
 - 3. Clean evaporator coils, reheat coils, and other airstream components.
- K. Duct Systems:
 - 1. Create service openings (access doors) in the HVAC system as necessary to accommodate cleaning.
 - 2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
- L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- M. Mechanical Cleaning Methodology:
 - 1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning

method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

- a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
 - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
2. Cleaning Mineral-Fiber Insulation Components:
- a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
 - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
 - c. Fibrous materials that become wet shall be discarded and replaced.

N. Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
3. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
6. Rinse thoroughly with clean water to remove any latent residues.

O. Antimicrobial Agents and Coatings:

1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.

2. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

3.4 CLEANLINESS VERIFICATION

- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.
- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- D. Additional Verification:
 1. Perform surface comparison testing or NADCA vacuum test.
 2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
- E. Verification of Coil Cleaning:
 1. Measure static-pressure differential across each coil.
 2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent the differential measured when the coil was first installed.
 3. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.
- F. Prepare a written cleanliness verification report. At a minimum, include the following:
 1. Written documentation of the success of the cleaning.
 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
 3. Surface comparison test results if required.
 4. Gravimetric analysis (nonporous surfaces only).
 5. System areas found to be damaged.

- G. Photographic Documentation: Comply with requirements in Division 01 Section "Photographic Documentation."

3.5 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Comply with requirements in Division 23 Section "Metal Ducts." Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Division 23 Sections "Metal Ducts" and "Nonmetal Ducts."
- D. Replace damaged insulation according to "Division 23 Section "HVAC Insulation."
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
- G. Reseal fibrous-glass ducts. Comply with requirements in Division 23 Section "Nonmetal Ducts."

END OF SECTION 230130

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Painting and finishing.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
 1. Manufacturers:
 - a. Epco Sales, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Epco Sales, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Rough brass.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 1. Finish: Rough brass.
- E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With exposed-rivet hinge and chrome-plated finish.

2.8 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.

- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
- M. Sleeves are not required for core-drilled holes.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - 1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- R. Verify final equipment locations for roughing-in.
- S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 230500

SECTION 230515 – VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Basic Requirements: Provisions of Section 23 01 00, BASIC MECHANICAL REQUIREMENTS are part of this Section.
- B. Related specifications: 260573.19 Arc-Flash Hazard Analysis, 260573.13 Short-Circuit Studies, 260573.16 Coordination Studies

1.2 SUMMARY

- A. General: Provide Variable Frequency Drives of the latest design and technology to provide adjustable frequency/speed control of motors, as indicated herein and on the Construction Documents. It is the intention of these specifications that the VFD controller shall be completely solid-state variable voltage source design.
- B. Chiller Controllers: This section specifically does not include variable frequency or speed controllers for Chillers.

1.3 QUALITY ASSURANCE

- A. Single Manufacturer: All VFD units shall be provided by a single manufacturer.
- B. Parts and Service: The VFD Manufacturer shall maintain, as part of a national network, Engineering and Parts service facilities to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.
- C. Standards: The VFD shall comply with latest IEEE 519 – “Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems”, and the latest applicable standards of ANSI, NEMA and the NEC. As a minimum, the full load output current rating of the drive shall be equal to 1.2 times the equivalent motor horsepower full load current (as listed by National Electric Code Table 430-150).
- D. Harmonics: The VFD's shall limit harmonic distortion reflected onto the source distribution system to a voltage and current distortion level as defined by IEEE 519. Harmonic calculations shall be provided with submittal. Field testing and certification is required as indicated separately in this specification.

1.4 SUBMITTALS

- A. General: Submittals shall be provided for all equipment herein specified including all data concerning dimensions, materials, efficiencies, installation instructions, wiring diagrams, UL data, and appropriate identification. Submittal shall include, but not be limited to, the following:
 - 1. Catalog cut sheet of each VFD being provided

2. Dimension of each VFD
 3. Detailed documentation of protection devices (fuses, breakers, ground fault protection, harmonic suppression, surge suppression)
 4. Factory Test Information
 5. Information on bypass switch operation and manual starter information
 6. Short circuit withstand rating of entire VFD assembly (drive and bypass), including UL testing information/data
 7. UL Listing / UL File Number
 8. IEEE 519 Calculations, provided by the VFD manufacturer, indicating calculated harmonic distortion levels with equipment being provided. Point of common coupling shall be at the secondary of the unit substation's transformer. Typical (unit substation's tie breaker open) and worst case (unit substation's tie breaker closed) calculations must be performed, both cases must pass voltage and current distortion limits. Note since this is a hospital and can be powered by onsite generation equipment, the most stringent distortion limits apply.
 9. Warranty Information
- B. General: Refer to paragraph entitled "SUBMITTAL" in Division 23010. Include the following material and performance data:
1. Manufacturers Literature:
 - a. Complete technical information on the Variable Frequency Drives and all specified options, indicating all cabinet dimensions and space requirements for the VFD, including bypass contactors and line reactors.
 - b. Wiring diagram with all control and power wiring for the Variable Frequency Drives Unit.
 2. Performance Data:
 - a. Complete efficiency versus load and speed data for all VFD ratings showing that the VFD with line reactors is capable of providing full motor nameplate rated horsepower.
 3. Installation Instructions:
 - a. Manufacturer's printed installation instructions including copies shipped with the equipment.
 - b. Manufacturer's instructions for the installation and checkout procedure for the Variable Frequency Drives unit.
 4. Maintenance Instructions:
 - a. Manufacturer's printed instructions for the maintenance of the Variable Frequency Drives unit.
 5. Manufacturer's Start-Up, Checkout and Instructions:
 - a. Start-up and checkout of the Variable Frequency Drives unit.
- C. Approval: VFDs shall not be ordered until submittals have been approved by the

Architect and shall bear the submittal approval stamp.

1.5 STORAGE AND HANDLING

- A. Sealing: Openings shall be sealed for shipping and remain so until installation.
- B. Handling: The equipment shall be carefully handled, not subjected to shock, and protected from weather, dust, construction materials and damage.

1.6 FACTORY TESTING AND CALCULATIONS

- A. Factory Testing and Warranty: All of the drive components shall be factory tested to ensure reliability.
- B. Efficiency Rating: Complete efficiency versus load and speed data for all VFD settings shall be submitted from factory testing and shall be no less than 95 percent at 100 percent speed and 87 percent at 60 percent speed. The VFD's shall maintain the line side displacement power factor no less than 0.95 regardless of speed and load.
- C. Motor Lead Length: It shall be the responsibility of the VFD manufacturer to determine if output filters are required based on motor lead lengths. Harmonic filters shall be provided as needed to achieve the maximum harmonic distortion levels specified herein.
- D. Point of Common Coupling: VFD manufacturer shall supply a harmonics estimation based on contractual one-line electrical drawings (to include all installed equipment for the project), at no charge, to ensure compliance with IEEE 519.
- E. Allowable Distortion Limits: Total at point of verification for Project for all assemblies:
 - 1. Voltage: $3\% = 100 \times \frac{\text{Total Harmonic Voltage (total units)}}{\text{Fundamental Voltage}}$
 - 2. Notch depth and notch volt - microseconds as defined by the latest edition of IEEE 519 Standard.
 - 3. Maximum harmonic current distortion in percent of fundamental shall be per IEEE 519 for specific count pulse unit
 - 4. Use of isolation and active filter devices is assumed by this specification, as required to obtain specified performance.
 - 5. Harmonic calculations shall be based on the kVA capacity and impedance of the transformer supplying the equipment power voltage. The Contractor shall supply this information to the VFD Manufacturer and active harmonic filter manufacturer.

PART 2 -

PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: The VFD shall be as produced by one of the following manufacturers. Other manufacturers are not acceptable and will not be considered.
 - 1. Basis of Design: ABB
 - 2. Yaskawa
 - 3. JCI/Eaton
- B. Requirements: VFD manufacturers listed here are not automatically approved for this project. All requirements of these specifications must be fully met for the VFD to be approved.

2.2 VARIABLE FREQUENCY DRIVE

- A. General: The Variable Frequency Drive shall be capable of converting the input voltage to variable frequency, three phase AC power for variable torque motor control continuously from 10 percent to 100 percent of base speed. A transformer shall not be used to adjust the input or output voltage. All general options and modifications shall mount within the VFD enclosure. The voltage-to-frequency ratio shall be automatically adjusted to maximize energy savings.
- B. Duty: The adjustable frequency system shall be continuous centrifugal duty stepless VFD matched to the motors provided with the equipment (i.e. fans and pumps). The VFD's shall be capable of operating any motor, regardless of manufacturer, with a load rating within the capacity of the VFD's.
- C. Microprocessor Based: The VFD's shall provide a microprocessor-based adjustment of three-phase motors.
- D. Pulse: The VFD's shall be of the 6 pulse for motors less than 100HP. Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. VFD's utilizing a third power section are not acceptable.
- E. Input Line Conditioning: Provide 5% impedance series line reactor or 5% DC choke with line-side MOVs as integral components for 10HP or less. Provide series harmonic LC trap filter inclusive with 5% impedance line reactor with line-side MOVs for greater than 10HP motors.
- F. VFD Output Filtering: Provide LC filter approved by motor manufacturer.
- G. Harmonic Filter: All VFD's on RTU & AHU units shall be provided with integral harmonic filter (TransCoil or equal).
- H. Operating Conditions: Standard operating conditions shall be:
 - 1. Incoming Power: Specified Voltage +5% to -10% and 60 hertz +/-2 hertz power to a fixed potential DC bus level.
 - 2. Humidity: 0 to 95% non-condensing and non-corrosive (indoor applications).
 - 3. Altitude: 0 to 3,300 feet above sea level.
 - 4. Ambient Temperature: 0 to 40 degrees C (indoor applications).
- I. Rotating Motor: The VFD's shall be able to start into a spinning motor. The VFD's shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD's shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor in the preset method of starting.
- J. Housing: VFD's located in dry interior spaces shall be housed in a NEMA 1 enclosure; VFDs located outside or in damp locations shall be provided with NEMA 3R weatherproof enclosure.

- K. Power Factor: Power Factor Correction capacitors shall not be utilized to meet motor performance criteria.
- L. Front Door: The front door of the controller shall include a door interlock disconnect switch. This shall prevent opening of the unit until the disconnect is in off position. Input fuses shall be provided.
- M. Manual Reset: The output power circuitry of the unit shall include a manual reset motor overload relay interlocked with the "on" circuitry of the unit. This shall be an adjustable solid-state device to allow easy field adjustment to motor nameplate amps.
- N. Minimum Withstand Rating: The entire Variable Frequency Drives assembly (drive, bypass and all components) shall be capable of a minimum withstand rating of 65,000 AIC or as indicated on the electrical drawings, for a minimum 3-cycles. The VFD assembly nameplate shall indicate that the entire assembly (not individual components) is rated at this minimum withstand rating. Test data indicating that the entire assembly has been tested to this rating shall be submitted to the Engineer for review.
- O. UL Listing: The entire Variable Frequency Drives assembly (drive, bypass and all components) shall be UL-listed as a single assembly. Individual component listings only shall not be acceptable. UL test data indicating that the entire assembly has been tested and approved by UL shall be submitted to the Engineer for review.

2.3 CONTROL AND MONITORING FUNCTIONS

- A. General: All VFD's programmable parameters shall be adjustable from a digital operator keypad located on the front door of the VFD or equivalent, convenient arrangement without opening the front door. Parameters shall include:
 - 1. Programmable maximum and minimum frequency.
 - 2. Programmable acceleration and deceleration times.
 - 3. Selectable carrier frequencies, V/Hz, and critical frequency avoidance lockout.
 - 4. Adjustable electronic overload and torque limits.
 - 5. Multiple attempt restart.
 - 6. Keypad lockout and factory default overrides.
- B. Display: The VFD's shall have a minimum of 8 character display indicating monitored functions as described in the preceding paragraph. The following parameters shall be monitored:
 - 1. Input current, RMS (3 phases)
 - 2. Input voltage, RMS (3 phases)
 - 3. Output current, RMS (3 phases)
 - 4. Output voltage, RMS (3 phases)
 - 5. Output frequency
 - 6. Kilowatts (input and output)
 - 7. Drive temperature
 - 8. Time
 - 9. Date
 - 10. Elapsed time meter
 - 11. Motor rpm

- C. Additional Features: The VFD's shall be additionally equipped with a digital operator station mounted on the enclosure. Control operator devices and indication lights shall include:
1. Digital speed control.
 2. Hand-Off-Auto control selector switch.
 3. LED status lights for HOA position.
 4. Local - remote speed control selector switch.
 5. LED status lights for local - remote switch position.
 6. LED status lights for run, fault, alarm, up-to-speed, and drive-ready status.
- D. Interface: The VFD's shall include the following system interfaces:
1. Two (2) isolated process control speed reference interfaces to receive and isolate 0-10 Vdc or 4-20 mAdc signals.
 2. One (1) analog output signal 0-10 Vdc for external metering.
 3. One (1) analog output signal 4-20mA for external metering.
 4. Run relay with an isolated set of form C contacts.
 5. Dedicated terminal blocks for interface with remote start contact and remote safety trips.
 6. 120 VAC control to allow VFD's to interface with remote contacts at a distance up to 500 feet and with three wire control.
 7. Unit mounted display indicating monitored and drive diagnostic information in English language. Coded messages are not acceptable.
 8. Dry contact output to indicate protective function trip.
 9. A 0 to 5 volt DC signal shall be provided for future use. A 4-20mA signal shall be provided for interface to controls system. The signals shall vary in direct proportion to the controller speed.
 10. The unit shall have a dedicated terminal block to allow the controller to be interconnected with external shutdown contacts, such as a smoke detector, fire detector, or time clock. If the unit is shut down by a remote alarm circuit (not including the time clock), a door mounted "external fault" light shall light.
 11. Standard Digital interface to the Building Control System in Section 23 09 00, in one of the following:
 - BACNet MS/TP
 - Modbus
- E. H-O-A Switch: The VFD keypad shall have an electronically controlled HOA switch:
1. When the switch is in the hand position, the unit shall be enabled and the potentiometer shall control speed.
 2. When the switch is in "auto" position, the controller shall be started and stopped by a contract closure, and the speed shall be controlled by an input control signal.
 3. In the auto position, the speed of the unit shall be controlled by a SPDT Null controller. If the sensor indicates that the speed is below required speed (i.e., the pressure is too low) the controller shall increase in speed.
 4. Conversely, when in the auto position, if the sensor indicates that the setpoint is

- being exceeded (i.e., the pressure is too high), the controller shall decrease in speed. If no signal is made, the controller shall remain at constant speed.
5. When the switch is in the "off" position, the motor shall be disconnected and shall not run.

- F. Acceleration/Deceleration: Acceleration time from 0 to full speed shall be adjustable from 30 to 300 seconds. Deceleration time shall be independently adjustable for the same range. A maximum frequency (speed) adjustment shall be available to allow less than 50 Hz output. A minimum frequency adjustment shall be available to set a minimum output frequency.

2.4 PROTECTION

- A. General: The VFD's shall be provided with means to protect itself and the motor from the following "faults":
1. Overload
 2. Speed compensated overcurrent.
 3. In-rush current limit (adjustable 50 to 150%)
 4. Undervoltage and Overvoltage
 5. Overtemperature
 6. Short Circuit (3-phase and line-to-line)
 7. Ground fault
 8. Input and output phase loss
 9. Overfrequency
- B. Overload Protection: The VFD's shall be protected from momentary overload / overcurrent conditions as indicated below:
1. The VFD shall have a one (1) minute overload current rating of 110% for variable torque loads or motor supplied. Unit capacities shall match equipment as minimum, increased to allow normal equipment overloads in actual installation. The VFD and its associated equipment shall be considered as an integral unit for performance as required by this Project.
 2. A current limiter shall be provided. The current limiter shall be designed to function automatically to prevent over current trip due to momentary overload conditions, allowing the inverter to continue operation, and achieve full design capacity of the motor and connected load.
- C. Overcurrent Protection: The line side of the VFD's shall be equipped with a current limiting reactor to reduce the amount of fault current to the VFD's, which is coordinated with available AIC at service.
- D. Overcurrent Trip: The instantaneous overcurrent trip shall safely limit the output current in proper microseconds interval due to phase short circuit or severe overload conditions.
- E. Undervoltage/Overvoltage/Phase Loss: An undervoltage trip shall protect the inverter due to non-momentary power or phase loss. The undervoltage trip shall activate automatically when the line voltage drops 15% below rated input voltage. The overvoltage trip shall protect the inverter due to voltage levels in excess of its rating.

- F. Temperature / Thermal Overload: An over temperature trip shall protect the inverter from elevated temperatures in excess of its rating.
 - 1. The over temperature light or indication on digital display shall indicate if the unit is tripped on over temperature.
 - 2. When the internal temperature is reduced to an acceptable level, the unit shall automatically start.
 - 3. The VFD panel shall provide visual indication when conditions are within 10 degrees F. of over-temperature shutdown, and upon shutdown.
 - 4. Motor Thermal Overload Protection shall be provided with door mounted reset button for the exact motor full load amps.
 - 5. Motor thermal overload relay shall be mounted inside the VFD cabinet.
- G. Short Circuit: In the event of a phase to phase short circuit, the control shall be designed to shut down safely without component failure.
- H. Ground Fault: Solid-state ground-fault protection and indication shall be provided with the VFD.
- I. Restart: The inverter logic shall allow that a trip condition resulting from over-current, under-voltage, or over-voltage shall automatically reset, and the inverter shall automatically restart upon correction of the trip condition. The number of restart attempts shall be limited to 5. If after 5 attempts the restart is not successful, the inverter shall shutdown safely and require manual restart.
- J. Loss of Power: In the event of a power loss, the control shall be designed to shutdown safely without component failure. Upon return of power, the system shall be designed to automatically return to normal operation (if the start is in the on condition) being able to restart into a rotating motor and regain positive speed control without shutdown or component failure.
- K. Switching: In the event that an input or output power contactor, disconnect switch, or circuit breaker is opened or closed while the control is activated, no damage to the unit shall result.

2.5 BYPASS MOTOR CONTROLLER

- A. Starter: VFD assembly shall contain a separate, across-the-line magnetic starter, sized to match motor and arranged for manually-activated emergency use in event of VFD system failure, controlled by same input data as VFD system. For motors over 30HP include a reduced voltage starter on the bypass circuit. Bypass circuit shall be protected by motor disconnect. Coordination, short-circuit, and arc flash study shall take into account bypass mode for settings and ratings.
- B. Bypass: The front door shall include the manual bypass switch. The bypass section door shall include a "VFD-Off-Bypass" selector switch, a "VFD Mode" indicator light and a "Bypass Mode" indicator light. Terminals shall be provided for remote indication of mode selection. In bypass mode the motor shall run at full speed directly from normal power. No electronic circuit shall be employed in the bypass mode. Motor protection thermal overload shall be provided in "bypass" and "normal" mode.

- C. Transfer: Manual bypass shall provide all the circuitry necessary to safely transfer the motor from the VFD to the power line, or from the line to the controller, while the motor is at zero speed. The bypass shall be located in the VFD section of the cabinet. The bypass section of the cabinet shall house all devices which must be energized at either line or control voltage while operating in the bypass mode.
- D. Contactors: Two motor contactors, electrically interlocked, shall be utilized. One contactor is to be between the VFD output and the motor, controlled by the VFD regulator; and the other one is to be between the bypass power line and the motor, providing across-the-line starting. The 115 VAC relay control logic, allowing common start-stop commands in the "controller" mode and the "bypass" mode shall also be included within the bypass enclosure.
- E. Interlock: The bypass option shall include a door interlocked, main power input disconnect, providing positive shutdown of all input power to both the bypass circuitry and the VFD.
- F. Factory Installed: Manual bypass with magnetic contactors shall be factory installed. Field modification of the VFD to provide manual bypass is not permitted.
- G. Optional Spare Drive: In lieu of bypass contactors, provide a minimum of two spare drives for each size VFD in the project. Submit a list of spare drives to be provided with the VFD submittal.

PART 3 -

EXECUTION

3.1 GENERAL

- A. General: Provide Variable Frequency Drives for each motor identified as requiring a VFD or variable speed operation.
- B. Mounting: Floor mounted Variable Frequency Drives units shall be installed on housekeeping pads. Refer to paragraph entitled "HOUSEKEEPING PADS AND EQUIPMENT SUPPORTS" in Division 23050.
- C. Wiring Diagrams: The VFD shall be provided with all necessary wiring diagrams for installation and power wiring from the manufacturer.
- D. Coordination: Coordinate each VFD with the motor served and with the Controls System, paying specific attention to the signal input/output and the ground source.
- E. Startup: The VFD manufacturer shall provide, at no additional cost to the owner, a start-up service package by a factory trained field service engineer for all VFDs provided. Service shall include inspection, final adjustments, operational checks, functional checks of spare parts (if provided) and a final report for record purpose. Start-up service shall be provided for each VFD. Start-up shall be performed with the cooperation of the controls sub-contractor and Commissioning Agent.
- F. Disconnect: Where a remote disconnect is provided for a motor controlled by a VFD, coordinate to ensure that a late make, early break auxiliary contact rated for ten (10) amps continuous duty is provided on the disconnect. This auxiliary contact must be wired into the VFD start circuit to ensure shut-down of the VFD in the event of the disconnect being opened.

- G. Warranty: The service package shall include a comprehensive three- year warranty (replacement parts and labor) from date of shipment, with certified drive start- up.

3.2 LOCATION OF VFD

- A. Location: The contractor shall coordinate the exact location of VFD with field conditions, keeping in mind that the locations shown on the construction drawings are diagrammatic.
- B. Distance from Motor: The maximum distance each VFD can be located from the motor it controls shall be as recommended by the manufacturer.
- C. Mounting: VFD may be mounted directly to masonry, CMU or concrete walls using appropriate fastening methods. When the wall is an exterior wall or any wall where condensation may occur, provide appropriate stand-off (i.e., insulation and/or unistrut mount). VFD may be mounted directly to equipment such as factory or field built AHU.
- D. Unistrut: When VFD is required to be located where suitable walls are not available, provide a Unistrut type frame securely mounted to the floor and adequately braced to form a rigid mounting surface.
- E. Floor Mounting: Provide 4" concrete housekeeping pad for all floor mounted units. Pad shall be 6" larger than VFD on all sides and shall have chamfered corners.
- F. Clearance: VFD shall be generally mounted with the center of the unit at a maximum of 60" above the finished floor. VFD's shall be accessible per the manufacturer's recommendations Service clearance shall be provided in accordance with NEC and under no circumstances less than the following:

Voltage to Ground	Min. Clearance Distance
0-120 V	3'-0"
121-277 V	4'-0"

3.3 AIR HANDLING UNIT SHUTDOWN

- A. Shutdown: When the VFD is used for control of an air handling unit or exhaust fan that is required to shut down upon activation of the fire alarm system, the VFD controller shall be connected to the fire alarm system and shall de-energize the VFD when the fire alarm system is in alarm. Coordinate with Division 26.
- B. H-O-A: The VFD shall be de-energized in "hand", "off", and "auto" modes. Switching between modes shall not reactivate motor until the fire alarm system is reset.
- C. Bypass: The VFD shall be de-energized in "VFD" and "Bypass" modes. Switching between modes shall not reactivate motor until the fire alarm system is reset.
- D. Restart: Upon reset of the fire alarm system and re-activation of the VFD, the motor shall "soft-start" and shall ramp up to its designated speed over a minimum of 30 seconds.

3.4 TRAINING

- A. Training: Provide a minimum of 4 hours of training for all VFDs for the Owner and

Owner's maintenance personnel.

END OF SECTION 230515

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Slip-joint packed expansion joints.
 - 2. Expansion-compensator packless expansion joints.
 - 3. Flexible-hose packless expansion joints.
 - 4. Metal-bellows packless expansion joints.
 - 5. Rubber packless expansion joints.
 - 6. Pipe loops and swing connections.
 - 7. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

- C. Welding certificates.
- D. Product Certificates: For each type of expansion joint, from manufacturer.
- E. Maintenance Data: For expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKED EXPANSION JOINTS

- A. Slip-Joint Packed Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adesco Manufacturing LLC.
 - b. Advanced Thermal Systems, Inc.
 - c. Hyspan Precision Products, Inc.
 - d. Metraflex
 - 2. Standard: ASTM F 1007.
 - 3. Material: Carbon steel with asbestos-free PTFE packing.
 - 4. Design: With internal guide and injection device for repacking under pressure. Include drip connection if used for steam piping.
 - 5. Configuration: Single joint with base class(es) unless otherwise indicated.
 - 6. End Connections: Flanged or weld ends to match piping system.

2.3 PACKLESS EXPANSION JOINTS

- A. Metal, Expansion-Compensator Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adscot Manufacturing LLC.
 - b. Flexicraft Industries.
 - c. Flex Pression Ltd.
 - d. Hyspan Precision Products, Inc.
 - e. Metraflex, Inc.
 - f. Unaflex.
 2. Minimum Pressure Rating: 175 psig unless otherwise indicated.
 3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
 4. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.
- B. Flexible-Hose Packless Expansion Joints:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Flex Pression Ltd.
 - d. Metraflex, Inc.
 - e. Unisource Manufacturing, Inc.
 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with weld end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with weld end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with weld end connections.
 - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

C. Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adsco Manufacturing LLC.
 - b. Flexicraft Industries.
 - c. Flex-Weld, Inc.
 - d. Hyspan Precision Products, Inc.
 - e. Metraflex, Inc.

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 175 psig unless otherwise indicated.
5. Configuration: Double joint with base class(es) unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Threaded.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
 - c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.
7. Expansion Joints for Steel Piping: Single- or multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
 - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
 - b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Weld.

2.4 GROOVED-JOINT EXPANSION JOINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Victaulic Company.
- B. Description: Factory-assembled packless expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints or gasketed slip-type with telescoping body, suitable for axial end movement up to 3".
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: Galvanized or plain steel (as required), ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- E. Couplings: Flexible type for steel-pipe dimensions. Number of couplings dependent on application. Include ferrous housing sections, EPDM gasket suitable for cold and hot water, and bolts and nuts.

2.5 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adesco Manufacturing LLC.
 - b. Advanced Thermal Systems, Inc.
 - c. Flex-Hose Co., Inc.

- d. Flexicraft Industries.
- e. Flex-Weld, Inc.
- f. Hyspan Precision Products, Inc.
- g. Metraflex, Inc.

- 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

- 1. Steel Shapes and Plates: ASTM A 36/A 36M.
- 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
- 3. Washers: ASTM F 844, steel, plain, flat washers.
- 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
- 5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.
- 6. Grooved System Engineered Pipe Anchors: An engineered pipe anchor used to assist in directing pipe movement in piping system risers. Floor-Mounted Riser Anchor: Engineered pipe anchor, NPS 2 to NPS 24 ; to assist in directing pipe movement in piping system risers. Standard weight carbon steel to ASTM A53 with orange enamel coating or Schedule 40 stainless steel to ASTM A312, type 304, with carbon steel brackets. Anchors suitable for system operating pressure to 500-psi . Basis of Design: Victaulic or Engineer-Approved Equal.
 - a. Accommodates pressures ranging from full vacuum (29.9 in Hg) up to 500 psi.
 - b. Standard weight carbon steel pipe conforming to ASTM A53 Grade B Type E. Roll-grooved ends.

7. Engineered Pipe Clamp: An engineered pipe clamp anchor can be connected to the existing concrete and steel structure to direct the piping movement and distribute the load from the piping system to the supporting structure. For use on Schedule 40 or greater carbon steel pipe for NPS 2 to NPS 12 . Victaulic A Series or Engineer-Approved Equal.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

- A. Provision for Expansion: Piping shall be installed with provisions for expansion both horizontally and vertically in all long runs including runouts from risers. Expansion loops and/or expansion elbows shall be provided for expansion and contraction where required and where shown on the drawings.
- B. Cold Springing of Pipe: Cold spring hot piping systems to reduce the amount of thermal expansion of the piping.
- C. Pipe Anchors: Provide pipe anchors as indicated or as required to eliminate excessive piping movement in thermal and pressure piping systems.
- D. Install expansion components where required and as noted.
- E. Install packed-type expansion joints with packing suitable for fluid service.
- F. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- G. Expansion fittings in all MEP utilities shall be provided at all expansion joints as indicated on architectural and structural drawings.
- H. Install grooved-joint expansion joints to grooved-end steel piping in accordance with manufacturer's guidelines. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. A direct employee of the manufacturer, factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. A distributor representative is not qualified for this site service on behalf of the manufacturer. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products without additional charges.
- I. In grooved installations, utilize manufacturer's Piping Systems Design group for formal review of movement solutions including product selection, product placement, anchor load calculations and PE stamping services if required.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.
- E. For water systems, Victaulic flexible couplings may be used to accommodate thermal contraction and expansion, and may be used in lieu of welded expansion loops. Where loops are required, use flexible type couplings on the loop corners and rigid couplings from anchors up to the loop. Drawings showing location and sizes of expansion loops shall be reviewed and approved by Victaulic Engineering Department including P.E. stamping services as required.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Link Seal
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pre-sealed Systems.
- B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.

- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Escutcheons.
- 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 ESCUTCHEONS

- A. One-Piece, Steel Type: With [polished, chrome-plated] [polished brass] finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type: With [polished, chrome-plated] [polished brass] finish and setscrew fastener.
- D. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping[and Relocated Existing Piping]:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece [steel] [cast brass][or split-plate steel] with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece steel with [polished, chrome-plated] [polished brass] finish.
 - d. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
 - e. Insulated Piping: One-piece cast brass with [polished, chrome-plated] [polished brass] finish.
 - f. Insulated Piping: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
 - g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with [polished, chrome-plated] [polished brass] finish.
 - h. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - i. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with [polished, chrome-plated] [polished brass] finish.
 - j. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
 - k. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with [polished, chrome-plated] [polished brass] finish.
 - l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - m. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with [polished, chrome-plated] [polished brass] finish.
 - n. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
 - o. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
 - p. Bare Piping in Unfinished Service Spaces: One-piece cast brass with [polished, chrome-plated] [rough-brass] finish.
 - q. Bare Piping in Unfinished Service Spaces: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
 - r. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.

- s. Bare Piping in Equipment Rooms: One-piece cast brass with [polished, chrome-plated] [rough-brass] finish.
 - t. Bare Piping in Equipment Rooms: One-piece stamped steel [or split-plate, stamped steel with concealed hinge] [or split-plate, stamped steel with exposed-rivet hinge] with polished, chrome-plated finish.
2. Escutcheons for Existing Piping to Remain:
- a. Chrome-Plated Piping: Split-plate, stamped steel with [concealed] [or] [exposed-rivet] hinge with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped steel with [concealed] [or] [exposed-rivet] hinge with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with [concealed] [or] [exposed-rivet] hinge with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with [concealed] [or] [exposed-rivet] hinge with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with [concealed] [or] [exposed-rivet] hinge with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with [concealed] [or] [exposed-rivet] hinge with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping [and] [Relocated Existing Piping]: Split floor plate.
 - 2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 230518

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Filled-system thermometers.
 - 3. Liquid-in-glass thermometers.
 - 4. Thermowells.
 - 5. Dial-type pressure gages.
 - 6. Gage attachments.
 - 7. Test plugs.
 - 8. Test-plug kits.
 - 9. Sight flow indicators.
 - 10. Pitot-tube flowmeters.
 - 11. Turbine flowmeters.
 - 12. Venturi flowmeters.
 - 13. Ultrasonic, thermal-energy meters.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Product Certificates: For each type of meter and gage, from manufacturer.
- D. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ashcroft Inc.
 - 2. Ernst Flow Industries.
 - 3. Marsh Bellofram.
 - 4. Trerice, H. O. Co.
 - 5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.

- 6. Weiss Instruments, Inc.
- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Marsh Bellofram.
 - c. Terrice, H. O. Co.
 - d. Weiss Instruments, Inc.
 - 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, cast aluminum or drawn steel; 5-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Plastic.
 - 9. Ring: Stainless steel.
 - 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
 - 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

- a. Design for Air-Duct Installation: With ventilated shroud.
- b. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Miljoco Corporation.
 - c. REOTEMP Instrument Corporation.
2. Standard: ASME B40.200.
3. Case: Sealed type, plastic; 5-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Plastic.
9. Ring: Metal.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Terrice, H. O. Co.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass or plastic.

8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 9. Connector: 3/4 inch, with ASME B1.1 screw threads.
 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- B. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Miljoco Corporation.
 - c. Tel-Tru Manufacturing Company.
 - d. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - e. Weiss Instruments, Inc.
 - f. WIKA Instrument Corporation - USA.
 2. Standard: ASME B40.200.
 3. Case: Plastic; 6-inch nominal size.
 4. Case Form: Back angle unless otherwise indicated.
 5. Tube: Glass with magnifying lens and blue or red organic liquid.
 6. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F.
 7. Window: Glass or plastic.
 8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 9. Connector: 3/4 inch, with ASME B1.1 screw threads.
 10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- C. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Tel-Tru Manufacturing Company.
 - c. Trerice, H. O. Co.
 - d. Weiss Instruments, Inc.
 - e. Winters Instruments - U.S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Plastic.
8. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.5 THERMOWELLS

- A. Thermowells:
 1. Standard: ASME B40.200.
 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 3. Material for Use with Copper Tubing: CNR or CUNI.
 4. Material for Use with Steel Piping: CRES.
 5. Type: Stepped shank unless straight or tapered shank is indicated.
 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 8. Bore: Diameter required to match thermometer bulb or stem.
 9. Insertion Length: Length required to match thermometer bulb or stem.
 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.6 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMETEK, Inc.; U.S. Gauge.

- b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Marsh Bellofram.
 - e. Trerice, H. O. Co.
 - f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - g. Weiss Instruments, Inc.
 - h. WIKA Instrument Corporation - USA.
 - i. Winters Instruments - U.S.
 2. Standard: ASME B40.100.
 3. Case: Liquid-filled type(s); cast aluminum or drawn steel 4-1/2-inch nominal diameter.
 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
 8. Pointer: Dark-colored metal.
 9. Window: Plastic.
 10. Ring: Stainless steel.
 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Marsh Bellofram.
 - d. Trerice, H. O. Co.
 - e. Weiss Instruments, Inc.
 - f. Winters Instruments - U.S.
 2. Standard: ASME B40.100.
 3. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 5. Match pressure connection size in first subparagraph below with gage attachment size.
 6. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 7. Movement: Mechanical, with link to pressure element and connection to pointer.
 8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
 9. Pointer: Dark-colored metal.
 10. Window: Plastic.
 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.7 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass ball, brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.8 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.
 - 2. Miljoco Corporation.
 - 3. National Meter, Inc.
 - 4. Peterson Equipment Co., Inc.
 - 5. Sisco Manufacturing Company, Inc.
 - 6. Trerice, H. O. Co.
 - 7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 8. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: EPDM self-sealing rubber.

2.9 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.
 - 2. Peterson Equipment Co., Inc.
 - 3. Sisco Manufacturing Company, Inc.
 - 4. Trerice, H. O. Co.
 - 5. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 6. Weiss Instruments, Inc.
- B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1-to-2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2-to-3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

2.10 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Archon Industries, Inc.
 - 2. Dwyer Instruments, Inc.
 - 3. Emerson Process Management; Brooks Instrument.
 - 4. Ernst Co., John C., Inc.
 - 5. Ernst Flow Industries.
 - 6. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.
 - 7. OPW Engineered Systems; a Dover company.
 - 8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 150 psig.
- E. Minimum Temperature Rating: 200 deg F.
- F. End Connections for NPS 2 and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.11 WATER FLOW METERS

- A. Electromagnetic Flow Meters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Onicon Incorp.
 - 2. Description: Flow meter that generates pulsating magnetic fields and relates this back to a sensor and indicator.
 - 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 250 deg F.
5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
6. Integral Transformer: For low-voltage power connection.
7. Accuracy: Plus or minus 1 percent.
8. Display: Shows rate of flow, with register to indicate total volume in gallons.
9. Operating Instructions: Include complete instructions with each flow meter.
- B. Pitot-Tube Flow Meters:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Emerson Process Management; Rosemount.
 - c. Meriam Process Technologies.
 - d. Preso Meters; a division of Racine Federated Inc.
 - e. TACO Incorporated.
 - f. Veris Industries, Inc.
 2. Description: Flowmeter with sensor and indicator.
 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 250 deg F.
 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
 6. Integral Transformer: For low-voltage power connection.
 7. Accuracy: Plus or minus 3 percent.
 8. Display: Shows rate of flow, with register to indicate total volume in gallons.
 9. Operating Instructions: Include complete instructions with each flowmeter.
- C. Turbine Flowmeters:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. ABB; Instrumentation and Analytical.
 - b. Data Industrial Corp.
 - c. EMCO Flow Systems; a division of Spirax Sarco, Inc.
 - d. ERDCO Engineering Corp.
 - e. Hoffer Flow Controls, Inc.
 - f. Liquid Controls; a unit of IDEX Corporation.
 - g. McCrometer, Inc.
 - h. Midwest Instruments & Controls Corp.
 - i. ONICON Incorporated.
 - j. SeaMetrics, Inc.
 - k. Sponsler, Inc.; a unit of IDEX Corporation.
2. Description: Flowmeter with sensor and indicator.
 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 4. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute.
 - a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
 - b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
 - c. Minimum Pressure Rating: 150 psig.
 - d. Minimum Temperature Rating: 180 deg F.
 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
 6. Accuracy: Plus or minus 1-1/2 percent.
 7. Display: Shows rate of flow, with register to indicate total volume in gallons.
 8. Operating Instructions: Include complete instructions with each flowmeter.

D. Venturi Flowmeters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Gerand Engineering Co.
 - c. Hyspan Precision Products, Inc.
 - d. Preso Meters; a division of Racine Federated Inc.
 - e. S. A. Armstrong Limited; Armstrong Pumps Inc.
 - f. Victaulic Company.
2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.

3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
 - a. Design: Differential-pressure-type measurement for water.
 - b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
 - c. Minimum Pressure Rating: 250 psig.
 - d. Minimum Temperature Rating: 250 deg F.
 - e. End Connections for NPS 2 and Smaller: Threaded.
 - f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
 - g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.
 - a. Scale: Gallons per minute.
 - b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
7. Display: Shows rate of flow, with register to indicate total volume in gallons.
8. Conversion Chart: Flow rate data compatible with sensor.
9. Operating Instructions: Include complete instructions with each flowmeter.

2.12 ULTRASONIC FLOW METER

A. Ultrasonic Transit Time Flowmeter:

1. The flowmeter must be a clamp on design precluding the requirement of penetrating into the pipe. The flowmeter shall be completely microprocessor based utilizing the transit time flow measurement technique. The flowmeter shall employ the phase detection multiple pulse transmit principle in conjunction with multiple frequency axial beam transducer technology to insure operation on liquids with solids and bubbles. In addition, the flowmeter shall incorporate an alternate Doppler method measurement mode for highly aerated or heavy solid bearing liquids. The furnished flowmeter shall be of a dual channel/path design. The dual channel operating mode shall be capable of acting as two independent meters with the ability to perform math functions between the two channels (add or subtract). The dual path operating mode will eliminate the effects of flow profile distortion, cross flow or swirl errors caused by upstream interference or pumping irregularities.

2. The flowmeter shall provide automatic transducer spacing for clamp-on transducers utilizing a Universal Mounting Frame or mounting track (ruler scales shall not be acceptable), the meter shall also support in-line transducers. The meter shall also provide automatic Reynolds Number and liquid sonic velocity variation compensation and live zero flow measurement. The flowmeter shall have the ability to indicate flow rate, flow velocity, total flow, signal strength, liquid sonic velocity, Reynolds Number and liquid aeration level. The flowmeter shall be equipped with an integral front panel keypad and multifunction LCD display. In addition, the flowmeter shall provide self and application diagnostics to isolate any fault conditions to either equipment failure or abnormal process conditions. The flowmeter shall have HELP menu routines corresponding to all levels of programming and operation.
3. The flowmeter electronics shall be housed in a NEMA 4X enclosure and powered by 120-VAC, 60Hz. Two isolated 4 to 20 maDC and two 0 to 5000 Hz pulse outputs proportional to flow shall be provided. The current outputs must be capable of driving a 1000-ohm resistive load. In addition, the unit shall provide two 0-to-10-volt outputs and four SPDT alarm relays assignable to flow velocity, liquid sonic velocity, signal strength or liquid aeration. An internal 250 KB (1 MB optional) datalogger shall be provided to allow storage of all measured and calculated variables and alarms.
4. A bi-directional RS-232 connection shall be provided to allow remote programming and interrogation.
5. The flowmeter shall have an accuracy of $\pm 1\%$ of flow over a $\pm .20$ fps flow range. Repeatability shall be $\pm 0.25\%$ of flow with a flow sensitivity of 0.001 fps at any flow rate including no flow conditions.
6. Flowmeters that employ amplitude detection/correlation routines or use a single frequency transducer design will not be acceptable. Shear mode flowmeters or meters utilizing wetted transducers or electrodes, or flow measuring techniques other than previously described will not be accepted.
7. Manufacturers:
 - a. Siemens Model FUS 1010 or FUE 1010.
 - b. Flo-Corp Ultra Flo FCX
 - c. Dynasonics TXFD

2.13 THERMAL-ENERGY METERS

A. Ultrasonic, Thermal-Energy Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. EMCO Flow Systems; a division of Spirax Sarco, Inc.
 - b. Siemens Energy & Automation, Inc.
 - c. Dynasonics

2. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
3. Flow Sensor: Transit-time ultrasonic type with transmitter.
4. Temperature Sensors: Insertion-type or strap-on transducer.
5. Indicator: Solid-state, integrating-type meter with integral battery pack.
 - a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
 - b. Battery Pack: Five-year lithium battery.
6. Accuracy: Plus or minus 1 percent.
7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
8. Operating Instructions: Include complete instructions with each thermal-energy meter system.
9. Building Control system interface: Provide communications network interface compatible with the Building Control System in Section 23 09 00 using BACNet MS/TP or TCP/IP communications standard.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

- I. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- J. Install valve and syphon fitting in piping for each pressure gage for steam.
- K. Install test plugs in piping tees.
- L. Install flow indicators in piping systems in accessible positions for easy viewing.
- M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- N. Install flowmeter elements in accessible positions in piping systems.
- O. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- P. Install permanent indicators on walls or brackets in accessible and readable positions.
- Q. Install connection fittings in accessible locations for attachment to portable indicators.
- R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- S. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic boiler.
 - 2. Two inlets and two outlets of each chiller.
 - 3. Inlet and outlet of each hydronic coil in air-handling units.
 - 4. Two inlets and two outlets of each hydronic heat exchanger.
- T. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3. Suction and discharge of each pump.
 - 4. Inlet and Outlet of each hydronic coil in air handling units.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.

- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
- B. Thermometers at inlets and outlets of each chiller shall be one of the following:
 - 1. Industrial style, liquid-in-glass type.
- C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
 - 1. Compact style, liquid-in-glass type.
- D. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
- E. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
 - 1. Liquid-filled, bimetallic-actuated type.
- F. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
- B. Scale Range for Condenser Water Piping: 20 to 120 deg F.
- C. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
 - 1. Liquid-filled, direct mounted, metal case.
- B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
 - 1. Liquid-filled, direct mounted, metal case.
- C. Pressure gages at suction and discharge of each pump shall be the following:
 - 1. Liquid-filled, direct mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
- B. Scale Range for Condenser-Water Piping: 0 to 100 psi.
- C. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.
- D. Scale Range for Steam Piping: 0 to 200 psi.

3.8 FLOWMETER SCHEDULE

- A. Flowmeters for Chilled-Water Piping: Ultrasonic type.
- B. Flowmeters for Condenser-Water Piping: Turbine type.
- C. Flowmeters for Heating, Hot-Water Piping: Ultrasonic type.
- D. Flowmeters for Steam and Steam-Condensate Piping: Venturi type.

3.9 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters for Chilled-Water Piping: Ultrasonic type.
- B. Thermal-Energy Meters for Condenser-Water Piping: Ultrasonic type.
- C. Thermal-Energy Meters for Heating, Hot-Water Piping: Ultrasonic type.
- D. Thermal-Energy Meters for Steam and Steam-Condensate Piping: Ultrasonic type.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Bronze angle valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Iron, grooved-end butterfly valves.
5. High-performance butterfly valves.
6. Bronze lift check valves.
7. Bronze swing check valves.
8. Iron swing check valves.
9. Iron swing check valves with closure control.
10. Iron, grooved-end swing-check valves.
11. Iron, center-guided check valves.
12. Iron, plate-type check valves.
13. Bronze gate valves.
14. Iron gate valves.
15. Bronze globe valves.
16. Iron globe valves.
17. Chainwheels.

- B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.

- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, unless indicated otherwise within each specific valve article.

1. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 2. Bray Commercial.
 3. Crane Fluid Systems; Crane Co.
 4. DeZURIK.
 5. Hammond Valve.
 6. Hays Fluid Controls.
 7. Jenkins Valves; a Crane Co. brand.
 8. Jomar Valve.
 9. Milwaukee Valve Company.
 10. NIBCO INC.
 11. Stockham; a Crane Co. brand.
 12. Viega LLC.
 13. WATTS; A Watts Water Technologies Company.
 14. Victaulic Company.
 15. Zurn Industries, LLC.
- C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream piping unless otherwise indicated.
- E. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 2. Handwheel: For valves other than quarter-turn types.
 3. Handlever: For quarter-turn valves NPS 6 and smaller
 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- F. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 3. Butterfly Valves: With extended neck.
- G. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Grooved: With grooves according to AWWA C606.
 3. Threaded: With threads according to ASME B1.20.1.
- H. Valve Bypass and Drain Connections: MSS SP-45.
- 2.2 BRONZE ANGLE VALVES
- A. Class 150, Bronze Angle Valves:
1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: PTFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

B. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Three piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange (Lug-Type) Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.

- c. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

B. Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Stainless steel.

2.5 IRON, GROOVED-END BUTTERFLY VALVES

A. 300 CWP, Iron, Grooved-End Butterfly Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Victaulic Company.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 2 and Larger CWP Rating: 300 psig.
 - c. Body Material: Grooved-end type, suitable for bidirectional dead-end service at rated pressure without use of downstream flange or cap.
 - d. Body Material: Coated, ductile iron.
 - e. Stem: Two-piece stainless steel, offset.
 - f. Disc: Electroless-nickel coated (non-elastomeric), ductile iron, offset.
 - g. Seal: Grade E or EHP (depending on size) EPDM. NPS 12 and smaller shall have pressure-responsive seat design.

2.6 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange (Lug-style), High-Performance Butterfly Valves:

- 1. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 285 psig at 100 deg F.

- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
- e. Seat: Reinforced PTFE or metal.
- f. Stem: Stainless steel; offset from seat plane.
- g. Disc: Carbon steel.
- h. Service: Bidirectional.

B. Class 300, Single-Flange (Lug-style), High-Performance Butterfly Valves:

1. Description:

- a. Standard: MSS SP-68.
- b. CWP Rating: 720 psig at 100 deg F.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
- e. Seat: Reinforced PTFE or metal.
- f. Stem: Stainless steel; offset from seat plane.
- g. Disc: Carbon steel.
- h. Service: Bidirectional.

2.7 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Design: Vertical flow.
- d. Body Material: ASTM B61 or ASTM B62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

2.8 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

1. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 300 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

2.9 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.

B. Class 250, Iron Swing Check Valves with Metal Seats:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A 126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.

2.10 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.
- i. Closure Control: Factory-installed, exterior lever and spring.

B. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.
- i. Closure Control: Factory-installed, exterior lever and weight.

2.11 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Victaulic Company.
- 2. Description:
 - a. NPS 2 to NPS 12, CWP Rating: 300 psig.
 - b. NPS 14 to NPS 24, CWP Rating: 230 psig.
 - c. Body Material: ASTM A536, ductile iron.
 - d. Seal: EPDM.
 - e. Disc: Spring operated, ductile iron or stainless steel.

2.12 IRON, CENTER-GUIDED CHECK VALVES

A. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

- 1. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Compact wafer.
 - f. Seat: Bronze.

B. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

- 1. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Compact wafer.
 - f. Seat: EPDM.

C. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Compact wafer.
 - f. Seat: EPDM.

D. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:

1. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Compact wafer, spring loaded.
 - f. Seat: EPDM.

2.13 IRON, PLATE-TYPE CHECK VALVES

A. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:

1. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - f. Seat: Bronze.

B. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:

1. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A126, gray iron.
 - f. Seat: Bronze.

C. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:

1. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.

- c. NPS 14 to NPS 24, CWP Rating: 250 psig.
- d. Body Design: Wafer, spring-loaded plates.
- e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
- f. Seat: EPDM.

D. Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:

1. Description:

- a. Standard: API 594.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Design: Wafer, spring-loaded plate.
- e. Body Material: ASTM A126, gray iron.
- f. Seat: EPDM.

E. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:

1. Description:

- a. Standard: API 594.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Design: Wafer, spring-loaded plates.
- e. Body Material: ASTM A126, gray iron.
- f. Seat: EPDM.

2.14 BRONZE GATE VALVES

A. Class 150, NRS Bronze Gate Valves:

1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, RS Bronze Gate Valves:

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.

- e. Stem: Bronze.
- f. Disc: Solid wedge; bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze, or aluminum.

2.15 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged or grooved.
- f. Trim: Bronze.
- g. Disc: Solid or flexible wedge.
- h. Packing and Gasket: Asbestos free.

C. Class 250, NRS, Iron Gate Valves:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.

D. Class 250, OS&Y, Iron Gate Valves:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.

2.16 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron.

B. Class 150, Bronze Globe Valves with Nonmetallic Disc:

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

2.17 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Description:

- a. Standard: MSS SP-85, Type I.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM A 126, gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Packing and Gasket: Asbestos free.

B. Class 250, Iron Globe Valves:

1. Description:

- a. Standard: MSS SP-85, Type I.
- b. CWP Rating: 500 psig.
- c. Body Material: ASTM A 126, gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Packing and Gasket: Asbestos free.

2.18 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

- 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
- 2. Attachment: For connection to ball and butterfly valve stems.
- 3. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc coating for exterior applications.
- 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Examine gasket seating surface areas on grooved-ended valves and adjoining sections of groove-end pipe for conditions that might cause leakage.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions, flanges, or grooved couplings as specified, at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly, gate, and globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. NPS 2 and Smaller, Shutoff Service: Ball valves.
 - 2. NPS 2-1/2 and Larger, Shutoff Service: Butterfly valves.
 - 3. Butterfly Valve Dead-End Service: Single-flange (lug) or grooved-end type. Provide a spool piece with diameter greater than the pipe diameter with a blind flange to allow regular exercising of the butterfly valve.
 - 4. Throttling Service except Steam: Ball or butterfly valves.
 - 5. Throttling Service, Steam: Globe or angle valves.
 - 6. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
 - c. All Pump-Discharge Check Valves shall be located a minimum of 5 pipe diameters from the pump discharge.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.

4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Copper Tubing and Steel Piping [**except Steam and Steam Condensate Piping**]: Valve ends may be grooved and shall be of the same manufacturer as the grooved-joint coupling system.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze disc.
3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, nonmetallic disc.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze or ductile-iron disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze or ductile-iron disc.
4. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 24: 300 CWP.
5. High-Performance Butterfly Valves: Class 150, single flange.
6. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
7. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
8. Iron, Grooved-End Check Valves, NPS 2-1/2 to NPS 12: 300 CWP.
9. Iron, Grooved-End Check Valves, NPS 14 to NPS 24: 230 CWP.
10. Iron, Center-Guided Check Valves: Class 150, compact-wafer, resilient seat.
11. Iron, Plate-Type Check Valves: Class 150, dual plate; resilient seat.
12. Iron Globe Valves: Class 125 .

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze disc.
3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, nonmetallic disc.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.

2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze or ductile-iron disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze or ductile-iron disc.
4. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 24: 300 CWP.
5. High-Performance Butterfly Valves: Class 150, single flange.
6. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
7. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
8. Iron, Grooved-End Check Valves, NPS 2-1/2 to NPS 12: 300 CWP.
9. Iron, Grooved-End Check Valves, NPS 14 to NPS 24: 230 CWP.
10. Iron, Center-Guided Check Valves: Class 150, compact-wafer, resilient seat.
11. Iron, Plate-Type Check Valves: Class 150, dual plate; resilient seat.
12. Iron Globe Valves: Class 125 .

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 150, bronze disc.
3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
4. Bronze Swing Check Valves: Class 150, nonmetallic disc.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze or ductile-iron disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze or ductile-iron disc.
4. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 24: 300 CWP.
5. High-Performance Butterfly Valves: Class 150, single flange.
6. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
7. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
8. Iron, Grooved-End Check Valves, NPS 2-1/2 to NPS 12: 300 CWP.
9. Iron, Grooved-End Check Valves, NPS 14 to NPS 24: 230 CWP.
10. Iron, Center-Guided Check Valves: Class 150, compact-wafer, resilient seat.
11. Iron, Plate-Type Check Valves: Class 150, dual plate; resilient seat.
12. Iron Globe Valves: Class 125 .

3.8 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Bronze Angle Valves: Class 150, bronze disc.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.

3. Bronze Swing Check Valves: Class 150, nonmetallic disc.
4. Bronze Gate Valves: Class 150, NRS.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. High-Performance Butterfly Valves: Class 150, single flange.
4. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
6. Iron Gate Valves: Class 125, NRS OS&Y.
7. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125.

3.9 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe NPS 2 and Smaller:

1. Bronze Angle Valves: Class 150, bronze disc.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Gate Valves: Class 150, NRS, bronze.
5. Globe Valves: Class 150, bronze, bronze disc.

B. Pipe Sizes NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Ball Valves, NPS 2-1/2 to NPS 10: Class 150, iron.
3. High-Performance Butterfly Valves: Class 150, single flange.
4. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
5. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and spring.
6. Iron Gate Valves: Class 125, NRS OS&Y.
7. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125.

3.10 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Angle Valves: Class 150, bronze disc.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Gate Valves: Class 150, NRS.
5. Bronze Globe Valves: Class 150, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
3. High-Performance Butterfly Valves: Class 150, single flange.
4. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
5. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
6. Iron Gate Valves: Class 125, NRS OS&Y.
7. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment supports.
- B. Related Sections:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
 - 3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
 - 4. Division 23 Section(s) "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Trapeze pipe hangers.
 2. Metal framing systems.
 3. Pipe stands.
 4. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Grinnell Corp.
 - 3. National Pipe Hanger Corporation.
 - 4. Tolco Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: PVC for use on copper piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.

- C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.

2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping and piping routed within concrete vaults.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. MIRO Industries.

- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 - 2. Base: Stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods. Pipe stands located in moisture prone environments (i.e. concrete vaults) shall be stainless steel.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. Portable Pipe Hangers.
 - 2. Bases: One or more plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
 - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
 17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction. All mechanical expansion anchors shall be approved by the Structural Engineer prior to use.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230533 – HEAT TRACE FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 26 Specification Sections

1.2 SUMMARY

- A. This Section includes heat tracing with the following electric heating cables:
 - 1. Plastic insulated, series resistance.
 - 2. Self-regulating, parallel resistance.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
 - 1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
 - 1. Verify available warranties for electric heating cable and insert number in subparagraph below.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
 - 2. Delta-Therm Corporation.
 - 3. Nelson Heat Trace.
 - 4. Raychem; a division of Tyco Thermal Controls.
 - 5. Thermon Manufacturing Co.
- B. Provide a complete system of heating-cables, components and controls, which shall be UL listed, FM Approved or CSA certified for the specific application and specific system for which they are used.
- C. The self-regulating heating cable shall consist of two (2) 16 AWG nickel-plated copper bus wires embedded in parallel in a self-regulating, cross-linked polymer core that varies its heat output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heati
- D. ng cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric inner jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall hav
- E. e a braid of tinned copper and an outer jacket of modified polyolefin or fluoropolymer, as required per section 427-23 of the NEC, latest edition.
 - 1. For installation on plastic piping, the heating cable shall be applied using aluminum tape (Raychem AT-180 or approved equal).
- F. Power connection, end seal, splice, and tee kit components shall be applied in the field.
- G. Heating cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC, latest edition.
- H. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion.
- I. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires or that use crimps or terminal blocks, shall not be acceptable.
- J. All components that make an electrical connection shall be re-enterable for servicing. No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE

2.3 HEATING CABLES FOR FREEZE PROTECTION

- A. Electrical Characteristics: See Electrical Drawings.
- B. In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40°F pipe temperature operation to 150°F pipe temperature operation.
- C. Maximum Operating Temperature Rating (Power On): 150°F.
- D. Maximum Exposure Temperature (Power Off): 150°F.
- E. Heat tracing for freeze protection of water piping shall be capable of maintaining a minimum water temperature of 50°F at an ambient air temperature of -30°F.
- F. The heating cable for metal-pipe freeze protection shall be sized according to the table below. The heating cable output ratings selected in this table are based on 1-inch fiberglass insulation. The given wattages refer to the nominal watts per foot rating, which corresponds to the standard heat output provided by the cable at a surrounding temperature of 50°F.

Pipe Size (inches)	Minimum Ambient Temperature	
	0°F	-20°F
3 or less	5 watts	5 watts
4	5 watts	8 watts
6	8 watts	12 watts
8	8 watts	12 watts
10	12 watts	2 strips - 8 watts
12	12 watts	2 strips - 8 watts
14	12 watts	2 strips - 12 watts
16	2 strips - 8 watts	2 strips - 12 watts
18	2 strips - 8 watts	2 strips - 12 watts
20	2 strips - 12 watts	2 strips - 12 watts
24	2 strips - 12 watts	3 strips - 12 watts

2.4 CONTROLS

- A. Local digital controller shall be DigiTrace C910-485 as manufactured by Raychem or approved equal.
 - 1. Heating cable manufacturer shall provide a local digital controller with built-in GFPD compatible with selected heating cable.
 - 2. Digital controller shall be capable of supporting up to two (2) RTD temperature sensors per control point. Leads can be extended using 18 AWG, 3-wire, shielded cable.
- B. Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP).

- C. Digital controller shall be capable of operating with supply voltages from 100 V to 277 V.
- D. Digital controller shall have an integrated adjustable Ground Fault Protection Device (10 – 200 mA).
- E. Digital controller shall have a built-in self-test feature to verify proper functionality of heating cable system.
- F. Digital controller shall be able to communicate with BMS via BACnet[®] protocol. Provide the controller manufacturer's recommended multi-protocol gateway (translator device) with controller as required.
- G. Digital controller will also supply an isolated triac alarm relay and a dry contact relay for alarm annunciation back to the BMS.
- H. The following variables shall be monitored by the digital controller and reported back to the BMS.
 - 1. Temperature
 - 2. Ground-fault
 - 3. Current draw
 - 4. Power consumption
 - 5. Associated alarms
- I. Digital controller shall have c-CSA-us approvals.
- J. Digital controllers serving freeze protection cables shall be configured for ambient sensing mode.

2.5 ACCESSORIES

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer, or as recommended in writing by manufacturer. Connection systems that require cutting or stripping to expose buswire, or that use crimps or terminal blocks will not be accepted.
- B. Warning Labels: Refer to Division 23 Section "Identification for HVAC Piping and Equipment."
- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install heat trace where indicated on drawings. and on all exposed outdoor makeup water piping.
- B. Install electric heating cable across expansion joints according to manufacturer's written recommendations using slack cable to allow movement without damage to cable.
- C. Install electric heating cables after piping has been tested and before insulation is installed.
- D. Install electric heating cables according to IEEE 515.1.
- E. Install insulation over piping with electric cables according to the insulation specification
- F. section. Coordinate diameter of insulation to include thickness of cable as per manufacturer's recommendations.
- G. Install warning tape on 10 foot centers on piping insulation where piping is equipped with electric heating cables.
- H. Set field-adjustable switches and circuit-breaker trip ranges.
- I. Protect installed heating cables, including nonheating leads, from damage.
- J. For heat tracing using line sensing, install temperature
- K. sensor in an area that is representative of conditions along entire length of pipe.
- L. Terminate cables with water-proof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end water-tight.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. A factory-certified technician or manufacturer's representative shall perform startup and commissioning of the heat trace system and controls. Provide commissioning report to owner.
- B. Coordinate all controller settings with specifying engineer prior to programming.
- C. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 1. Test cables for electrical continuity and insulation integrity before energizing.
 - 2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.
- E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 230533

SECTION 230548 - VIBRATION CONTROLS FOR HVAC AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Restrained spring isolators.
 - 5. Housed spring mounts.
 - 6. Elastomeric hangers.
 - 7. Spring hangers.
 - 8. Spring hangers with vertical-limit stops.
 - 9. Pipe riser resilient supports.
 - 10. Resilient pipe guides.
 - 11. Restrained vibration isolation roof-curb rails.
 - 12. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
 - 1. Basic Wind Speed: 125 MPH.
 - 2. Building Classification Category: Risk Category IV.
 - 3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: C.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: Risk Category IV.
 - a. Component Importance Factor: 1.5.
 - b. Component Response Modification Factor: 6.0.

- c. Component Amplification Factor: 2.5.
- 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.109g.
- 4. Design Spectral Response Acceleration at 1-Second Period: 0.044g.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

- 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
- 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Annotate to indicate application of each product submitted and compliance with requirements.
- 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings

- 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For vibration isolation device.

- 1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
- 3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
- 4. Seismic and Wind Restraint Details
 - a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

- c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Welding certificates.
- C. Qualification Data: For professional engineer.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.8 APPROVED MANUFACTURERS

- A. The vibration control equipment in this Section is based upon the products of Mason Industries, Inc., other acceptable manufacturers are as listed per product type.

PART 2 – PRODUCTS

2.1 ISOLATOR TYPE A (ELASTOMERIC ISOLATION PADS)

- A. Elastomeric Isolation Pads:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type NK or comparable product by one of the following:
 - a. Ace Mountings Co., Inc.
 - b. Kinetics Noise Control, Inc.
 - c. Vibration Isolation.
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area. Sandwich cork with two layers of neoprene waffle.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Pad Material: Oil and water resistant with elastomeric properties.
 - 5. Surface Pattern: Waffle pattern.
 - 6. Minimum ½ inch thickness.
 - 7. Load-bearing metal plates adhered to pads.

2.2 ISOLATOR TYPE B (ELASTOMERIC ISOLATION MOUNTS)

- A. Double-Deflection, Elastomeric Isolation Mounts:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type ND or comparable product by one of the following:

- a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 ISOLATOR TYPE C (RESTRAINED ELASTOMERIC ISOLATION MOUNTS)

- A. Restrained Elastomeric Isolation Mounts:
 1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. - Type BR or comparable product by one of the following:
 - a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
 2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 ISOLATOR TYPE D (OPEN -SPRING ISOLATORS)

- A. Freestanding, Laterally Stable, Open-Spring Isolators:
 1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type SLF or comparable product by one of the following:
 - a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
 7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5 ISOLATOR TYPE E (HOUSED -SPRING ISOLATORS)

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type C or comparable product by one of the following:
 - a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top housing with attachment and leveling bolt.

2.6 ISOLATOR TYPE F (RESTRAINED -SPRING ISOLATORS)

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type SLR or comparable product by one of the following:
 - a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 ISOLATOR TYPE G (ELASTOMERIC HANGERS)

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type HD or comparable product by one of the following:
 - a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.8 ISOLATOR TYPE H (SPRING HANGERS)

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type DNHS or comparable product by one of the following:
 - a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.9 ISOLATOR TYPE I AND K (VIBRATION ISOLATOR EQUIPMENT BASES)

- A. Manufacturers: Subject to compliance with requirements, provide product by Mason Industries, Inc. or comparable product with one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Vibro-Acoustics
- B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails. Mason Industries, Inc. – Type WFSL – (TYPE I)

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete. Mason Industries, Inc. – Type KSL - (TYPE K)
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.10 ISOLATOR TYPE L (RESTRAINED ISOLATION ROOF CURB RAILS)

- A. Manufacturers: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type CMAB or comparable product with one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Vibro-Acoustics
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.
- C. Upper Frame: Upper frame shall provide continuous and captive support for equipment.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.11 FLEXIBLE PIPE CONNECTORS AND GUIDES

- A. Manufacturers: Subject to compliance with requirements, provide products by Mason Industries, Inc or comparable product by one of the following:
 - 1. Amber Booth
 - 2. Proco
 - 3. Victaulic.
- B. (TYPE N) Flexible Pipe Connector: Flexible stainless steel hose constructed of stainless steel braid and carbon steel fittings. Connections: Male threaded ends for piping 2-1/2 inches and smaller and flanged ends for piping 3 inches and larger. Lengths as recommended by manufacturer. Mason Industries, Inc. – Type FFLSS
- C. (TYPE O) Non-ferrous single arch expansion joint connector fabricated of multiple plies of nylon cord, fabric and neoprene; furnished with metallic flanges which are independent of the casing and retained by beaded ends which fit into machined grooves, forming a liquid tight seal without gasketing. Provide bolted stabilizing/control rods to maintain anchoring where required, due to size or operating pressure. Mason Industries, Inc. – Type SFEJ
- D. (TYPE P) Non-ferrous twin arch expansion joint connector fabricated of multiple plies of nylon cord, fabric and neoprene; furnished with metallic flanges which are independent of the casing and retained by beaded ends which fit into machined grooves, forming a liquid tight seal without gasketing. Provide bolted stabilizing/control rods to maintain anchoring where required, due to size or operating pressure. Mason Industries, Inc. – Type SFDEJ
- E. (TYPE Q) Pipe Guide: stainless steel wrapping the carbon steel foot where it passes through horizontal U guides similarly lined to prevent corrosion. The baseplate shall have multiple holes for bolting to beam flanges or flat surfaces. Bases may be welded in position in lieu of bolting. Height must be adjustable to accept different thicknesses of insulation. Guides shall be professionally load rated for bottom, overhead, side mounted or riser positioning to provide both load bearing and guiding capabilities. Mason Industries, Inc. – Type ASG
- F. (TYPE R) Pipe Guide: Spider type, using stainless steel ring and mounting plate, with a pipe ring and guide shield sized to accept the pipe insulation thickness. Mason Industries Type SPG.
- G. (TYPE S) Pipe Anchor: All directional acoustical pipe anchor, consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2 inch thickness of heavy duty neoprene and duck or neoprene isolation material. Vertical restraints provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolator material not to exceed 500 PSI and the design balanced for equal resistance in any direction. Mason Industries Type ADA.
- H. On Victaulic installations, Styles 77, 177, or W77 flexible couplings may be used in lieu each flexible connector for vibration isolation and noise reduction at equipment connections. Three (3) couplings for each connector shall be placed in close proximity to the source of vibration in accordance with manufacturer's guidelines.

2.12 SNUBBERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CADDY; a brand of nVent.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
 - 4. Vibration Management Corp
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

2.13 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CADDY; a brand of nVent.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
 - 4. Vibration Management Corp
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.14 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CADDY; a brand of nVent.
 - 2. Vibration Management Corp
- B. Restraint Cables: ASTM A492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.15 SEISMIC RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business
 - 2. CADDY; a brand of nVent.
 - 3. Mason Industries, Inc.

- B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.16 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. Hilti, Inc.
 - 3. Mason Industries, Inc.
 - 4. Powers Fasteners.
 - 5. Simpson Strong-Tie Co., Inc.
 - 6. Unistrut; Part of Atkore International.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING IN MECHANICAL EQUIPMENT AND AIR HANDLING UNIT ROOMS

- A. General:
 - 1. Isolators for equipment and piping are described elsewhere in this division. The vibration isolation manufacturer shall coordinate the selection of piping supports with equipment supports to provide a carefully engineered system designed to accommodate expansion and contraction without excessive stress or misalignment at equipment connections or in the piping.

2. Temporary anchors, where required, shall be installed to permit pre-adjustment of springs in risers.
 3. Permanent limit stops shall be installed to prevent excessive vertical motion of risers in the event water is drained from system. Locations and other details of these limit stops shall be submitted to the Architect for acceptance.
 4. Piping connected to vibration isolated equipment shall not strain or force out of alignment the vibration isolators supporting the basic equipment, nor shall pipes restrict such equipment from "floating" freely on its respective vibration isolation system.
 5. Piping connected to vibrating equipment shall not physically contact any building construction or non-isolated systems or components.
 6. The weight of the pipe shall not be carried by walls through which the pipe passes.
- B. At Equipment Connections:
1. At the pump outlet, provide isolator TYPE N.
 2. At the chilled and hot water supply and return connections to the air handler, provide isolator TYPE M.
 3. At locations shown on the drawings for pipe guides, provide guide TYPE P or Q, and anchors provide TYPE R
- C. Equipment with Internal Isolation:
1. Air handlers, Rooftop Units with internally isolated fans, that call for external isolation, shall lock down internally isolated components (if provided).
 2. Air Cooled Chillers, Compressorized Condensing units with internally isolated compressors to be grade mounted, shall utilize manufacturer's specified and listed anchoring system to comply with the delegated design. Where the manufacturer's internal isolation system does not meet the performance requirements in Part 1, a specified isolation system shall be used in Parts 2 and 3.

3.3 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Specifications.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.4 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Specifications.

3.5 VIBRATION ISOLATION SCHEDULE

- A. Provide mechanical equipment with vibration isolation according to the following

schedule:

<u>EQUIPMENT</u>	<u>ISOLATOR TYPE</u>
Base mounted pumps	D, [I] or [K], and [N] [O] [P]
Inline pumps	A
Air handling units – floor mounted	[A] [D and K]
Air handling units – vertical - floor mounted	[B] [C]
Air handling units – suspended	[G] [H]
Air handling unit – custom	M
Condensing units	[B] [C] [D]
Fans - Suspended	[G] [H]
Fans - floor mounted	[B] [C] [D and L]
Fans – Roof mounted (utility type)	D
Centrifugal Chiller	[A] [F]
Cooling Tower	[F]
Rotary Chiller	[A] [F]
Boiler	[A]
Temperature Control Air Compressor	[D]
Packaged Rooftop Air Conditioning Units	[L]

B. Provide the following piping systems with vibration isolation according to PART 3 of this Section:

1. Chilled Water Piping
2. Hot Water Piping
3. Refrigerant Piping
4. Condenser Water Piping
5. Steam Supply and Steam Condensate Return Piping

3.6 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

- E. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change in direction longer than 12 feet.
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- J. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.7 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch minimum thickness and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 4. Fasteners: Stainless-steel rivets or self-tapping screws.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Blue.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches.

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten engraved plastic labels on each major item of mechanical equipment specifically including VAV boxes, Constant Volume Boxes, Electric Duct Heaters, Wall Heaters, Fan Coils, Blower Coils, AHU's, Chillers, Boilers, Water Softeners, Condensate Return Units, Deaerators, Surge Tanks, etc.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. General: Paint all exposed piping, insulation, equipment, structural bases, racks, in equipment rooms and on roof, furnished under Division 23 of these specifications. All exposed metal surfaces shall be given one prime coat and two finish coats. All insulated surfaces shall be given one coat of glue sizing (omit this step if factory applied finish is suitable to receive prime coat), one prime coat and one finish coat. Factory painted or

finished items do not require field painting but shall require "touch-up" with matching paint or finish where scratched. Follow manufacturer's recommendations on ambient conditions for painting, coat thickness, and drying time between coats.

- B. Inaccessible Items: Equipment not completely accessible for painting when set in place shall be thoroughly cleaned and painted before installation and suitably protected.
- C. Concealed Items: Concealed piping need not be painted.
- D. Metal Surfaces: Use a scraper or wire brush to remove rust and roughen metal surfaces prior to painting. After wire brushing, wash surfaces to remove particulates, apply primer coat after surface is dry but not more than 48 hours after wire brushing.
- E. Colors: Colors for piping systems and equipment which are required to be painted shall be as indicated in the following table:

TABLE - PIPING PAINTING SCHEDULE

Class	Paint Color
F – Fire Protection Equipment	Red
D – Dangerous Material	Yellow (or Orange)
S – Safe Material	Green (or the achromatic colors White, Black, Gray or Aluminum)
P – Protective Material	Bright Blue
V – Valuable Material	Deep Purple

- F. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 10 feet along each run.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
 - 8. Piping above each room or space that it passes over shall receive a label; specifically, all piping in each space (or room) shall receive a label.
- G. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping:

- a. Background Color: Blue.
 - b. Letter Color: White.
2. Condenser-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
3. Heating Water Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: White.
4. Refrigerant Piping:
 - a. Background Color: Black.
 - b. Letter Color: White.
5. Low-Pressure Steam Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: White.
6. High-Pressure Steam Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: White.
7. Steam Condensate Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 1. Blue: For cold-air supply ducts.
 2. Yellow: For hot-air supply ducts.
 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 20 feet in each space where ducts are exposed or concealed by removable

ceiling system. Ductwork above each room or space that it passes over shall receive a label; specifically, all ductwork in each space (or room) shall receive a label.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Chilled Water: 2 inches round.
 - b. Condenser Water: 2 inches round.
 - c. Refrigerant: 2 inches round.
 - d. Hot Water: 2 inches round.
 - e. Gas: 1-1/2 inches, round.
 - f. Low-Pressure Steam: 2 inches, round.
 - g. High-Pressure Steam: 2 inches, round.
 - h. Steam Condensate: 2 inches, round.
 - 2. Valve-Tag Color:
 - a. Chilled Water: Natural.
 - b. Condenser Water: Natural.
 - c. Refrigerant: Natural.
 - d. Hot Water: Natural.
 - e. Gas: Natural.
 - f. Low-Pressure Steam: Natural.
 - g. High-Pressure Steam: Natural.
 - h. Steam Condensate: Natural.
 - 3. Letter Color:
 - a. Chilled Water: Black.
 - b. Condenser Water: Black.
 - c. Refrigerant: Black.
 - d. Hot Water: Black.
 - e. Gas: Black.
 - f. Low-Pressure Steam: Black.
 - g. High-Pressure Steam: Black.
 - h. Steam Condensate: Black.

3.6 WARNING-TAG INSTALLATION

Write required message on, and attach warning tags to, equipment and other items where required.

3.7 OWNER VERIFICATION

- A. All tags - color identification of all systems shall be reviewed with the Owner prior to release of shop drawings.
- B. All color coding for labels, paint, tags, etc shall be reviewed and confirmed by owner prior to submitting.

3.8 EXISTING FACILITIES

- A. Existing facilities under renovation or expansion shall match existing facility standard for color coding for labels, paint and tags.

END OF SECTION 230553

SECTION 230593 – TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. General: The Contractor will select a test and balance agency (herein referred to as the T&B Agency) and pay for the services of the T&B Agency for system and equipment performance verification. T&B Agency shall be awarded at the beginning of the project and is expected to participate in the construction kick-off meeting with the owner.
- C. Definition of Terms: Contractor shall refer to the General Contractor. Owner shall refer to Washington Adventist Hospital or their designated representative.

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Constant-flow hydronic systems.
 - b. Variable-flow hydronic systems.
 - c. Primary variable flow hydronic system.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

- A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

- B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Owner shall engage a TAB entity certified by NEBB or AABC.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by NEBB or AABC.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by NEBB or AABC as a TAB technician.
- B. TAB Conference: Meet with Architect, Owner, Construction Manager and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect and Commissioning Authority.

- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Notice: Provide seven (7) days advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to

rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units; such as variable-air-volume boxes and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.
- P. Provide support for commissioning activities and functional performance testing as outlined in the Commissioning Plan.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or AABC's "National Standards for Total System Balance" and in this Section.
 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return-and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.

- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow:
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment:
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for

air- handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 1. Measure airflow of submain and branch ducts:
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
 2. Check liquid level in expansion tank.
 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
- D. Systems installed with pressure-independent control valves shall require verification of flow for 25% of the total number of installed valves, unless otherwise indicated herein. Exact locations of tested valves shall be coordinated with the Engineer and Commissioning Authority.

3.7 PROCEDURES FOR CONSTANT FLOW HYDRONIC SYSTEMS

- A. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- B. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- C. Set calibrated balancing valves, if installed, at calculated presettings.
- D. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- E. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- F. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

- H. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- I. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 - 1. Entering and leaving water temperature.
 - 2. Water flow rate.
 - 3. Water pressure drop.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.
 - 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.

- C. Measure, adjust, and record the following data for each steam coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Airflow.
 - 3. Air pressure drop.
 - 4. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.11 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.12 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Settings for supply-air, static-pressure controller.
 - g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches (mm), and bore.
 - n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 2. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.

- b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.
- H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Air flow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- a. System and air-handling-unit number.
- b. Location and zone.
- c. Traverse air temperature in deg F.
- d. Duct static pressure in inches wg.
- e. Duct size in inches.
- f. Duct area in sq. ft.
- g. Indicated air flow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual air flow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Apparatus used for test.
- d. Area served.
- e. Make.
- f. Number from system diagram.
- g. Type and model number.
- h. Size.
- i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Air velocity in fpm.

- c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- M. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.14 INSPECTIONS

- A. Initial Inspection:
 - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
 - 2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.
- B. Final Inspection:

1. Report Availability: One copy of the final Test and Balance Report shall be made available at the project site for the AHCA final survey. This final report shall be typewritten and submitted to the Architect prior to the final survey with sufficient time for review, comment, correction of report, additional testing as necessary, follow-up review, and acceptable signature by the Architect. The Test and Balance Report shall include differential pressure testing of each duct smoke detector, verifying that each reading falls within the manufacturer's acceptable tolerance.
 2. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
 3. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.
 4. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 5. If more than 10% of the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 6. If the number of "FAILED" measurements is greater than 10% percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
 3. Final Completion: AHCA: Final completion certificate and payment shall be withheld pending receipt of the letter from AHCA which details the final survey deficiency comments and does not indicate that the test and balance data requires further submission and review.
- D. Prepare test and inspection reports.

3.15 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions. TAB shall not be responsible for changes in the system due to facility management/maintenance changes from time of substantial completion.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - 2. Adhesives.
 - 3. Mastics.
 - 4. Lagging adhesives.
 - 5. Sealants.
 - 6. Factory-applied jackets.
 - 7. Field-applied fabric-reinforcing mesh.
 - 8. Field-applied cloths.
 - 9. Field-applied jackets.
 - 10. Securements.
 - 11. Corner angles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of

insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

- E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 97-13.
- F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. ITW TACC, Division of Illinois Tool Works; CB-25.
 - d. Marathon Industries, Inc.; 501.
 - e. Mon-Eco Industries, Inc.; 55-10.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
 - d. Mon-Eco Industries, Inc.; 55-70.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 5. Color: White.

- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 200 deg F.
 - 4. Solids Content: 63 percent by volume and 73 percent by weight.
 - 5. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. For indoor applications, use lagging adhesives that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Inc.; 130.
 - d. Mon-Eco Industries, Inc.; 11-30.
 - e. Vimasco Corporation; 136.
 - 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
 - 4. Service Temperature Range: Minus 50 to plus 180 deg F.
 - 5. Color: White.

2.5 SEALANTS

- A. Joint Sealants:
 - 1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 - f. Vimasco Corporation; 750.

2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-70.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 3. Materials shall be compatible with insulation materials, jackets, and substrates.
 4. Permanently flexible, elastomeric sealant.
 5. Service Temperature Range: Minus 100 to plus 300 deg F.
 6. Color: White or gray.
 7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: Aluminum.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 5. Color: White.
 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products: Subject to compliance with requirements, provide the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Vimasco Corporation; Elastafab 894.

- B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; Chil-Glas No. 5.

- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: White.

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricates fitting covers only if factory-fabricated fitting covers are not available.

- E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard; Insulrap No Torch 125.
- F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Polyguard; Alumaguard 60.
- G. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
- H. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
- I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.10 SECUREMENTS

- A. Bands:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.

- d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 - 3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 - 4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.080-inch nickel-copper alloy.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.

2.11 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant

- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 - 2. Pipe: Install insulation continuously through floor penetrations.
 - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
 - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - 3. Protect exposed corners with secured corner angles.
 - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not over-compress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.

- g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
 7. Stagger joints between insulation layers at least 3 inches.
 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
 1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
 1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 2. Fabricate boxes from aluminum at least 0.050 inch thick.
 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

- A. Insulation Installation on Boiler Breechings and Ducts:
 1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
 3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at

least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.
- E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over-compress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.11 PHENOLIC INSULATION INSTALLATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.12 POLYISOCYANURATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of polyisocyanurate insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.13 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.14 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.15 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with

weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-pre-sized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install pre-sized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.16 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.17 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.18 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
 - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.19 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in nonconditioned space.
 - 4. Indoor, exposed return located in nonconditioned space.
 - 5. Outdoor, concealed supply and return.
 - 6. Outdoor, exposed supply and return.
- B. Items Not Insulated:
 - 1. Factory-insulated flexible ducts.
 - 2. Factory-insulated plenums and casings.
 - 3. Flexible connectors.
 - 4. Vibration-control devices.
 - 5. Factory-insulated access panels and doors

3.20 INDOOR DUCT INSULATION SCHEDULE

- A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- B. Concealed, round and flat-oval, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- D. Concealed, rectangular, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
- E. Concealed, rectangular, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- F. Concealed, rectangular, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- G. Exposed, round and flat-oval, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- H. Exposed, round and flat-oval, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- I. Exposed, round and flat-oval, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- J. Exposed, rectangular, supply-air duct insulation in the Mechanical Rooms to 6 feet above finish floor, shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- K. Exposed, rectangular, return-air duct insulation in the Mechanical Rooms to 6 feet above finish floor, shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- L. Exposed, rectangular, outdoor-air duct insulation in the Mechanical Rooms to 6 feet above finish floor, shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- M. Exposed, supply-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

- N. Exposed, return-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- O. Exposed, outdoor-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.

3.21 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, heat-recovery bundles suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Flexible Elastomeric: 2 inches thick.
- D. Heat-exchanger (water-to-water for heating service) insulation shall be one of the following:
 - 1. Calcium Silicate: 3 inches thick.
 - 2. Mineral-Fiber Board: 3 inches thick and 2-lb/cu. ft. nominal density.
- E. Chilled-water pump insulation shall be the following:
 - 1. Cellular Glass: 3 inches thick.
- F. Chilled-water expansion/compression tank insulation shall be the following:
 - 1. Cellular Glass: 1-1/2 inches thick.
 - 2. Flexible Elastomeric: 1 inch thick.
- G. Heating-hot-water expansion/compression tank insulation shall be the following:
 - 1. Calcium Silicate: 2 inches thick.
- H. Chilled-water air-separator insulation shall be one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Flexible Elastomeric: 2 inches thick.
- I. Heating-hot-water air-separator insulation shall be one of the following:
 - 1. Calcium Silicate: 3 inches thick.
 - 2. Mineral-Fiber Pipe and Tank: 2 inches thick.
- J. Piping system filter-housing insulation shall be one of the following:
 - 1. Cellular Glass: 3 inches thick.
 - 2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

3. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.22 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.23 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- B. Chilled Water and Brine, 40 Deg F and below:
 1. NPS 3 and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
 2. NPS 4 to NPS 12: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 3. NPS 14 and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
- C. Chilled Water and Brine, above 40 Deg F:
 1. NPS 12 and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
 2. NPS 14 and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.

- D. Heating-Hot-Water Supply and Return, 200 Deg F and below:

1. NPS 12 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inch thick.
- E. Refrigerant Suction and Hot-Gas Piping:
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
- F. Hot Service Drains:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Calcium Silicate: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.
- G. Hot Service Vents:
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Calcium Silicate: 1-1/2 inches thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.
- H. Medium Pressure Steam and Condensate
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 4.5 inch thick.
- I. Low Pressure Steam and Condensate
 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 3 inch thick.
- J. Steam Vents**
 - 1. All Pipe Sizes: Insulation shall be one of the following:**
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2.5 inch thick.**
- K. Glycol Runaround Piping**
 - 1. NPS 12 and Smaller: Insulation shall be the following:**
 - a. Cellular Glass: 2 inches thick.**

3.24 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine:

1. All Pipe Sizes: Insulation shall be the following:

- a. Cellular Glass: 3 inches thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and below:

1. All Pipe Sizes: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

- a. Flexible Elastomeric: 2 inches thick.

D. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be the following:

- a. Calcium Silicate: 1-1/2 inches thick.

E. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be the following:

- a. Calcium Silicate: 1-1/2 inches thick.

F. Steam Vents**1. All Pipe Sizes: Insulation shall be one of the following:**

- a. Mineral-Fiber, Preformed Pipe, Type I: 2.5 inch thick.**

3.25 PREFABRICATED UNDERGROUND PIPING

A. General: Provide factory pre-insulated underground piping for the underground distribution system. The carrier piping shall be of the following material and connections:

Material:

- Schedule 40 Black Steel – chilled water
- Connection Type: Welded

B. Chilled water piping shall be provided with a factory-installed insulation layer of nominal 2-inch thick (actual 2.2" thick) polyurethane foam insulation complying with the insulating requirements of ASHRAE Standard 90.1-2010, and protected by an outer jacket of high density polyethylene (HDPE) material.

- C. The insulation jacket joints shall be joined by watertight couplings, and seals shall completely encapsulate the insulation at each end. Fittings shall also be factory pre-insulated and shall comply with the requirements listed above for straight pipe lengths. The piping shall be designed to withstand 150 psig working pressure at 250 degrees F.
- D. Manufacturers:
 - Rovanco Piping Systems
 - Thermal Pipe Systems, Inc.
 - Perma-Pipe/Ricwil Piping Systems (steam/condensate MT 500, chilled Double Therm)
 - Thermacor
- Provide Engineered Shop Drawings for Submittal E.O.R. Review

3.26 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Provide exterior jacket for all outdoor piping insulation. Outdoor insulated ductwork shall be double wall without exposed insulation.
- B. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- C. If more than one material is listed, selection from materials listed is Contractor's option.
- D. Piping, Concealed:
 - 1. Aluminum, Smooth: 0.020 inch thick.
- E. Piping, Exposed:
 - 1. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 230700

SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.
- B. All applicable requirements of Section 230500 Common Work Results for HVAC shall apply to this entire Section and shall have the same force and effect as if fully included herein.

1.2 SUMMARY

- A. General: This section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of systems defined for control on this project.
- C. The control system shall be designed such that each mechanical system will operate under stand-alone control. As such, in the event of a network communication failure, or the loss of other controllers, the control system shall continue to independently operate the unaffected equipment.
- D. The owner presently has an existing Siemens Desigo Building Automation System. The intent of this specification is to extend and interoperate this system and to provide a peer-to peer, networked control system for the control work that is part of this project. All components, software and operation shall be interoperable with the existing building automation system. The installed system will interface directly with the existing system. The existing software and database will be modified to accept the new trending, programming and alarming. Computer based icons that "link" to a separate system are not acceptable. Any costs associated with connecting with the existing Energy Management System including and not limited to onsite investigation, licensed software, programming, training, etc., shall be part of the control contractor's bid. The contractor must demonstrate the ability to perform the integration to the existing systems prior to submittal acceptance. All systems as described in the construction documents will be shown via dynamic graphics with all pertinent system alarms for proper operation and maintenance. The use of separate workstations, gateways, metalinks, replacement of existing controllers and control devices, and additional software graphic packages to accomplish this integration will not be accepted.

1.3 DEFINITIONS

- A. BAS: Building Automation System
- B. Control Contractor: Contractor for this section
- C. DDC: Direct digital control.
- D. I/O: Input/output.

- E. MS/TP: Master slave/token passing.
- F. PC: Personal computer.
- G. PID: Proportional plus integral plus derivative.
- H. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 - 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 - 8. Provide web-based multi-protocol open control system.
 - 9. Graphic Display: Intuitive, web-based user interface with custom color graphics and floor plans.
 - 10. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Space Temperature: Plus or minus 1 deg F.
 - b. Ducted Air Temperature: Plus or minus 1 deg F.
 - c. Outside Air Temperature: Plus or minus 2 deg F.
 - d. Dew Point Temperature: Plus or minus 3 deg F.
 - e. Temperature Differential: Plus or minus 0.25 deg F.
 - f. Relative Humidity: Plus or minus 5 percent.
 - g. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - h. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - i. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - j. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - k. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - l. Carbon Monoxide: Plus or minus 5 percent of reading.
 - m. Carbon Dioxide: Plus or minus 50 ppm.
 - n. Electrical: Plus or minus 5 percent of reading.

1.5 ACTION SUBMITTALS

- A. Prior to final release, owner must approve controls package.
- B. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
 - 4. Details of control panel faces, including controls, instruments, and labeling.
 - 5. Written description of sequence of operation.
 - 6. Schedule of dampers including size, leakage, and flow characteristics.
 - 7. Schedule of valves including flow characteristics.
 - 8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 - 9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 - 10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.

d. Points list.

- D. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- E. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

1.6 INFORMATIONAL SUBMITTALS

- A. Prior to final release, owner must approve controls package.
- B. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- C. Qualification Data: For Installer and manufacturer.
- D. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- E. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

- A. Prior to final release, owner must approve controls package.
- B. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 5. Calibration records and list of set points.
- C. Software and Firmware Operational Documentation: Include the following:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
 - 5. Software license required by and installed for DDC workstations and control systems.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, thermostat.
2. Maintenance Materials: One thermostat adjusting key(s).
3. Maintenance Materials: One pneumatic thermostat test kit.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.11 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordination location of control panels, dampers, valves, and devices such that clearance can be maintained for proper access to all components.
- C. Coordinate equipment with existing fire alarm system to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate and assist Testing, Adjusting and Balancing (TAB) Contractor with proper set up and operation of HVAC Systems.
- E. The minimum quantity of DDC/ATC panels are located on the contract documents. Provide additional panels as required. All panel locations must be approved by the Owner and Architect and coordinated with all trades prior to installation. If approval and/or coordination are not completed, then panels shall be relocated at no cost to owner.
- F. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- G. Control contractor shall provide all conduit and accessories, etc. required for power and control wiring to his devices.
- H. Control contractor shall interlock fans or pumps through hard wiring where indicated on contract documents; software interlocks shall not be acceptable.

- I. Coordinate equipment with Section 262416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.

PART 2 – PRODUCTS

2.3 Control System

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- B. Provide extension of existing Siemens Desigo control system consisting of sensors, controllers, indicating devices, interface equipment, other apparatus, and accessories to operate mechanical equipment and to perform functions as specified. Update all existing data bases and incorporate new graphics.
- C. Provide all materials and field work necessary for a complete system
- D. Provide an electric motor for each damper and valve to be controlled, unless one is specified elsewhere.
- E. Unless specified otherwise, provide fully modulating components.
- F. Unless specified otherwise, provide proportional/integral/inverse derivative components for variable air volume controls, proportional/integral components for air handling unit discharge control, and fully proportional/integral components elsewhere.
- G. Motors that respond to incremental "pulse" signals or do not fail to the specified position shall not be acceptable.
- H. Provide all electrical wiring, communication cabling, relays or other devices for interlocking of equipment as described in Sequence of Operations or as shown on drawings.
- I. DDC system shall be capable of operating in environmental conditions of 30 deg F to 120 F and 10% RH to 90% RH noncondensing. Sensors and final control elements shall be capable of operating in environment in which they are installed.
- J. Graphics: New global graphics to provide a user friendly interface to the new and existing detail graphics. Provide an overall riser diagram page which will allow instant access to new floor plan graphic pages, individual air handling units and central plants. An individual floor plan graphic will be provided for each floor of the building. The floor plan will show air handling zone layout and provide a link to the associated air handler graphic within each zone. Each space temperature available on the DDC system shall be interactively displayed on the floor plan. Provide sub-area graphics as required to fit all temperatures.

2.4 DDC CONTROLLER INTEGRATION TO EXISTING BAS NETWORK

- A. Prior to physically connecting the new DDC Controllers to the existing system, the BAS contractor shall print a predefined report listing any points that are failed, in alarm, or overridden in the system. Once the integration is complete, verify through the same reports that no additional existing points are failed, in alarm, or overridden.
- B. Once the new DDC controllers are commissioned, the BAS contractor shall assist the Owner's rep to make the physical connection to the existing network.
- C. Once the tie-in is complete, the BAS contractor shall confirm communication with the server.
- D. Upload all data to the server.
- E. Verify there are no new failed existing points on the system. If so, take corrective action to resolve discrepancies.
- F. Create graphics that represent the new systems, including but not limited to AHU layouts, navigation, screens, and room graphics.
- G. Map all alarmable points into the existing remote notification software installed on the server.

2.5 DDC EQUIPMENT

- A. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:
 - 1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 - 2. Processor: Intel Pentium 4.
 - 3. Random-Access Memory: 1,024 MB.
 - 4. Graphics: Video adapter, minimum 1024 x 768 pixels, 64 MB video memory.
 - 5. Monitor: 17 inches, LCD color.
 - 6. Keyboard: QWERTY 105 keys in ergonomic shape.
 - 7. Floppy-Disk Drive: 1.44 MB.
 - 8. Hard-Disk Drive: 800 MB.
 - 9. CD-ROM Read/Write Drive: 48x24x48.
 - 10. Pointing Device: Touch pad or other internal device.
- B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.

- d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
- 3. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - d. Remote communications.
 - e. Maintenance management.
 - f. Units of Measure: Inch-pound and SI (metric).
- 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- 5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
 - 1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - 3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 - 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - 1. Binary Inputs: Allow monitoring of on-off signals without external power.
 - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 - 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.6 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72 hour battery backup.
 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
 3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
 4. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
 5. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
 6. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.7 ALARM PANELS

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch-thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
 - 1. Alarm Condition: Indicating light flashes and horn sounds.
 - 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 - 3. Second Alarm: Horn sounds and indicating light is steady.
 - 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 - 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.8 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
- E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
 - 1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
 - 2. Proportional band shall extend from 2 to 20 percent for 5 psig.
 - 3. Authority shall be 20 to 200 percent.
 - 4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
 - 5. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.9 TIME CLOCKS

- A. Manufacturers:
 - 1. ATC-Diversified Electronics.
 - 2. Grasslin Controls Corporation.
 - 3. Paragon Electric Co., Inc.
 - 4. Precision Multiple Controls, Inc.
 - 5. SSAC Inc.; ABB USA.
 - 6. TCS/Basys Controls.
 - 7. Theben AG - Lumilite Control Technology, Inc.
 - 8. Time Mark Corporation.
- B. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
- C. Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.10 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 - 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. Ebtron, Inc.
 - c. Heat-Timer Corporation.
 - d. I.T.M. Instruments Inc.
 - e. MAMAC Systems, Inc.
 - f. RDF Corporation.
 - 2. Accuracy: Plus or minus 0.5 deg F at calibration point.
 - 3. Wire: Twisted, shielded-pair cable.
 - 4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
 - 5. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft..
 - 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
 - 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

- a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Exposed.
 - c. Thermometer: Concealed
 - d. Orientation: Horizontal.
 - 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 - 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- C. RTDs and Transmitters:
- 1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. MAMAC Systems, Inc.
 - c. RDF Corporation.
 - 2. Accuracy: Plus or minus 0.2 percent at calibration point.
 - 3. Wire: Twisted, shielded-pair cable.
 - 4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
 - 5. Averaging Elements in Ducts: 24 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
 - 6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
 - 7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Exposed.
 - c. Thermometer: Concealed
 - d. Orientation: Horizontal.
 - 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 - 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- D. Humidity Sensors: Bulk polymer sensor element.
- 1. Manufacturers:
 - a. ROTRONIC Instrument Corp.
 - b. Vaisala
 - c. General Eastern
 - 2. Accuracy: 5 percent full range with linear output.
 - 3. Room Sensor Range: 20 to 80 percent relative humidity.
 - 4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.

- d. Orientation: Horizontal.
 - 5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
 - 6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.
 - 7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
 - E. Pressure Transmitters/Transducers:
 - 1. Manufacturer: Setra
 - 2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 0.25-inch wg.
 - d. Duct Static-Pressure Range: 0- to 5-inch wg.
 - 3. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
 - 4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.
 - F. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - 1. Set-Point Adjustment: Concealed.
 - 2. Set-Point Indication: Concealed.
 - 3. Thermometer: Concealed.
 - 4. Orientation: Horizontal.
 - G. Room sensor accessories include the following:
 - 1. Insulating Bases: For sensors located on exterior walls.
 - 2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
 - 3. Adjusting Key: As required for calibration and cover screws.
- 2.11 STATUS SENSORS
- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
 - B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
 - C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

2.12 GAS DETECTION EQUIPMENT

- A. Manufacturers:
 - 1. Honeywell International Inc.
 - 2. MSA Canada Inc.
 - 3. TSI Incorporated.
 - 4. Vaisala.
 - 5. Vulcain Inc.
- B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 50 and 100 ppm.
- C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- D. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- E. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.13 FLOW MEASURING STATIONS

- A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.
- B. Manufacturers:
 - 1. Air Monitor Corporation.
 - 2. Wetmaster Co., Ltd.
 - 3. Others with proper approval by Engineer

- C. Casing: Galvanized-steel frame.
- D. Flow Straightener: Aluminum honeycomb, 3/4-inch (20-mm) parallel cell, 3 inches (75 mm) deep.
- E. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

2.14 THERMOSTATS

- A. Manufacturers:
 - 1. Erie Controls.
 - 2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
 - 3. Heat-Timer Corporation.
 - 4. Sauter Controls Corporation.
 - 5. tekmar Control Systems, Inc.
 - 6. Theben AG - Lumilite Control Technology, Inc.
- B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
 - 1. Label switches "FAN ON-OFF".
 - 2. Mount on single electric switch box.
- C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
 - 1. Automatic switching from heating to cooling.
 - 2. Preferential rate control to minimize overshoot and deviation from set point.
 - 3. Set up for four separate temperatures per day.
 - 4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
 - 5. Short-cycle protection.
 - 6. Programming based on weekday, Saturday, and Sunday.
 - 7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
 - 8. Battery replacement without program loss.
 - 9. Thermostat display features include the following:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.

- g. System mode indications include "heating," "off," "fan auto," and "fan on."
- D. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
- E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
- F. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
- G. Selector Switch: Integral, manual on-off-auto.
- H. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 - 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 - 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 - 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- I. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, and the following:
 - 1. Reset: Manual.
 - 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- J. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- K. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- L. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual or automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 - 1. Bulb Length: Minimum 20 feet (6 m).

2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
- M. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual or automatic reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
1. Bulb Length: Minimum 20 feet (6 m).
 2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
- N. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.15 HUMIDISTATS

- A. Manufacturers:
1. MAMAC Systems, Inc.
 2. ROTRONIC Instrument Corp.
 3. Vaisala
- B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.16 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
 5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Manufacturers:

- a. Belimo Aircontrols (USA), Inc.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: Minus 22 to plus 122 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
12. Run Time: 12 seconds open, 5 seconds closed.

2.17 DAMPERS

- A. Manufacturers:
 1. Air Balance Inc.
 2. Don Park Inc.; Autodamp Div.
 3. Ruskin
 4. United Enertech Corp.
 5. Vent Products Company, Inc.
- B. Dampers: AMCA-rated, opposed blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
 1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated

steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.18 CONTROL CABLE

- A. Electronic and fiber-optic cable3.1s for control wiring are specified in Section 271500 "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.
- B. Verify that duct, pipe, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

- A. General
 1. Equipment manufacturer shall provide factory installed, unit mounted controls with BACNET capability.
 2. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
 3. Connect and configure equipment and software to achieve sequence of operation specified.
 4. Install automatic dampers according to Section 233300 "Air Duct Accessories."
 5. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
 6. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."
 7. Install refrigerant instrument wells, valves, and other accessories according to Section 232300 "Refrigerant Piping."
 8. Install duct volume-control dampers according to Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."
- B. Thermostats and Temperature Sensors
 1. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

2. Install devices 48 inches above the floor.
 3. Provide insulation pads for thermostats and/or temperature sensors mounted on exterior walls and columns.
 4. Install averaging elements in ducts and plenums in crossing or zigzag pattern across the area of duct or plenum in order to sense true average temperature. Secure averaging elements in such a manner as to prevent vibration from causing element fatigue.
 5. Secure duct mounted sensors to ductwork in a vibration free area.
 6. Furnish thermal wells for sensors to be installed in piping. Furnish extension necks where installed in insulated piping. Material for wells shall be compatible with material of piping where installed.
 7. Install guards on thermostats in the following locations:
 - a. Entrances.
 - b. Public areas.
 - c. Where indicated on plan.
- C. Humidistats and Humidity Sensors
1. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.
 2. Install devices 48 inches above the floor.
 3. Secure duct mounted sensors to ductwork in a vibration free area.
- D. Low Temperature Limit Thermostats
1. Install sensing element serpentine across coil to provide full coil sensing.
 2. Setpoint shall be adjustable. Initial setting at 35 deg F. Wired to stop fan and alarm DDC system.
 3. Provide a low temperature limit thermostat for every 20 square feet of coil area.
 4. Install on entering side of cooling coil unless otherwise shown elsewhere on the drawings.
- E. Control Valves
1. Tag each valve with brass or aluminum tag with corresponding number on control drawings. Tag shall identify valve number and be attached to valve with non-ferrous metal chain.
- F. Control Valves
1. Tag each valve with brass or aluminum tag with corresponding number on control drawings. Tag shall identify valve number and be attached to valve with non-ferrous metal chain.
- G. Control Dampers

1. Verify size and locations of control dampers with Mechanical Contractor prior to fabrication. Locations of dampers shall be reviewed to ensure that maximum velocity rating is not exceeded.

H. Airflow Measuring Station

1. Verify size and locations of duct mounted airflow stations with Mechanical Contractor prior to fabrication. Locations of airflow stations shall be reviewed to ensure that adequate straight run distances are provided.

I. Control Panels

1. Mount control panels adjacent to associated equipment either on walls or freestanding on steel supports. Mounting on ductwork or air handling units will not be permitted. Panels shall be free from vibration.
2. Panels shall be securely mounted with vertical and lateral bracing.

J. Current Switches

1. Shall be installed such that core is securely in place.
2. Shall be adjusted such that calibration trip point will detect drive belts slipping, breaking, or pump coupling shear.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Provide signal and power wiring to all panels and devices furnished under the contract and signal and safety device wiring to all equipment controlled under this contract.
- B. Provide all interlock wiring between equipment being sequenced as required to accomplish the sequence of operations, which shall include, but not be limited to, supply and return air fans, exhaust fans, coil circulating pumps, chilled and condenser water pumps, cooling tower fans and chiller control panels, flow switches, etc. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- C. Mount and wire all loose control components provided with packaged equipment.
- D. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."
- E. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Install signal and communication cable according to Section 271500 "Communications Horizontal Cabling."
 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Install exposed cable in raceway.
 3. Install concealed cable in raceway.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- G. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 4. Pressure test high-pressure control air piping at 150 psig (1034 kPa) and low-pressure control air piping at 30 psig (207 kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
 5. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 6. Test each point through its full operating range to verify that safety and operating control set points are as required.
 7. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 8. Test each system for compliance with sequence of operation.
 9. Test software and hardware interlocks.
- C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check installation of air supply for each instrument.

6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.

- b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 - 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 - 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 - 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 - 10. Provide diagnostic and test instruments for calibration and adjustment of system.
 - 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 TESTING, ADJUSTING AND BALANCING

- A. Testing, adjusting and balancing of air and water systems will be provided under Division 23 "Testing, Adjusting and Balancing of HVAC Systems".
- B. Cooperate with testing, adjusting and balancing Contractor in coordination and scheduling of testing, balancing and adjusting work, as well as determining appropriate set point adjustments required for proper system operation.
- C. Provide notice upon completion of all preparatory work and all initial operational testing required as part the Work. Perform additional operational testing on equipment, or systems, as directed and to extent and for duration deemed necessary, to demonstrate that systems are performing properly and delivering quantities in accordance with the requirements of the Contract Documents.
- D. BAS Contractor shall set up and calibrate the mass flow control devices to the design contract values. BAS Contractor shall adjust the Air Volume Control Box (AVCB) control so that final setup does not deviate more than plus or minus 5 percent from the design value.
- E. BAS Contractor shall index the system configuration as requested by the TAB Contractor.
- F. BAS Contractor shall obtain static pressure readings from TAB Contractor at the various points in the system for programming and tuning final set point conditions.

3.7 COMMISSIONING

- A. Commissioning will be provided as specified in Division 23 Section "Commissioning". All contractors and subcontractors of the various sections of this specification shall cooperate and participate in the commissioning work in accordance with requirements of Division 23 Section "Commissioning".
- B. Ensure participation of major equipment manufacturers or their representatives.
- C. Equipment and systems/subsystems installed under this section are expected to be in full compliance with the design intent by the commissioning phase. Notify the Commissioning Agent when any specific piece of equipment or specific system/subsystem is ready for commissioning. Be prepared to demonstrate system readiness.
- D. Equipment or systems/subsystems having incomplete work or exhibiting problems related to noncompliance with the design intent shall require commissioning. The contractor for this section shall be fully responsible to make all necessary corrections to incomplete or non-complying work at their own expense and shall pay the Commissioning Agent per diem rate for recommissioning such incomplete or non-complying work. BAS Contractor shall obtain static pressure readings from TAB Contractor at the various points in the system for programming and tuning final set point conditions.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training."
- B. Upon completion of all work and tests, operate systems for a sufficient length of time to demonstrate to Owner, mode of operation and definitively determine whether the system as a whole is in first class working condition. Before systems are turned over to Owner, a final demonstration test of 48 continuous hours, during which systems shall operate without adjustment, shall be performed.
- C. Before installation is accepted, provide certification to Owner and Architect that control system and equipment have been inspected and found to be properly installed and functioning satisfactorily.

END OF SECTION 230900

SECTION 230933 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes requirements for system operation for HVAC equipment.
- B. Related Sections
 - 1. Division 23 09 00 "Instrumentation and Controls for HVAC"

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATIONS

- A. Chiller Plant
 - 1. Chilled Water Plant System Description:
 - a. General: The chilled water system is designed to be operational at all times under the automatic BAS program control. Primary equipment and auxiliary devices are located within the Central Utility Plant. The chilled water system consists of:
 - 1. (3) 750-ton water cooled magnetic bearing chillers (plus one future chiller)
 - 2. (3) constant speed primary chilled water pumps (plus one future pump)
 - 3. (2) variable speed secondary chilled water pumps (plus one future pump)
 - 4. (3) cooling towers (plus one future cooling tower)
 - 5. (3) condenser water pumps (plus one future pump)
 - b. Related hydronic accessories, piping, valves, sensors, meters, switches and other miscellaneous control devices shall be provided as shown in the drawings.
 - c. Each chiller is equipped with an automatic isolation valve located at the condenser water outlet of each shell.
 - d. Diagnostic information availability: operational status of each equipment and various analog and digital control points associated with the system shall be available to the operator at the BAS Workstation at all times over the BAS communication link bus.
 - e. System Operation Approach: The system is designed to constantly produce and supply chilled water to the hospital at a supply water temperature (CHWST) of 42 degrees F. the system is also designed to operate at an essentially constant chilled water return temperature (CHWRT) of 54 degrees F. The chilled water supply temperature sensors located downstream from each water loop discharge header will serve as the system "master" supply water temperature control points.

2. Initial Start: When activated by the BAS, each chiller shall operate from its own integral, unit mounted chiller control panel. Which communicates operating parameters bi-laterally at all times with the BAS building controller via the BAS communication link bus.
3. Under automatic program control, the chilled water system shall start by first enabling the lead plant equipment. The lead chiller and pumps shall be the ones with the least run time. The starting of the first chiller shall open chilled water and condenser water valves for that chiller and then energize the pumps. When additional chillers are energized, another chilled water and condenser water pump shall be energized and after a short time delay, the next chiller condenser and chilled water valve shall open. The time delay shall be tuned such that the operating chiller[s] shall not be stopped due to a low flow condition. For any "idle" chiller to start and operate, all of the following requirements must be satisfied:
 - a. Cooling tower isolation valve and condenser water side inlets 2-position, NC "auto-isolation valves" will slowly move from closed to fully open within 15 seconds (reprogrammable) and proven open via digital input from valve end switch to BAS.
 - b. The lead condenser water pump shall be enabled by the BAS. Control of the lead cooling tower fan shall be enabled when proof of run is established for the lead condenser water pump.
 - c. Condenser water flow rate through the chiller shall then be proven at all times by differential pressure sensor installed in local condenser water connections at chiller.
 - d. The lead cooling tower water piping circulation sub-system shall be operational.
 - e. The associated lead chilled water pump shall be started through digital output to the starter from the BAS.
 - f. Chilled water flow through the chiller shall then be proven as monitored at all times by an analog input from the differential sensor/transmitter installed across local evaporator piping connections at the chiller.
 - g. Entering condenser water minimum and maximum temperature conditions shall be satisfied and reset as required by the BAS based on wet bulb temperature.
 - h. The entering cooler (evaporator) water temp shall not be greater than 55 deg F (reprogrammable).
 - i. Associated BAS Start/Stop contact (digital output) to unit-mounted control panel and compressor motor starter shall then be closed to allow chiller to begin and complete manufacturer's start-up sequence programmed into chiller control panel.
 - j. For each chiller, the BAS shall modulate the chilled water isolation valve to maintain the differential pressure setpoint across the evaporator and shall reset the chilled water pump differential pressure setpoint if unable to maintain the minimum differential pressure across the chiller evaporator.
4. Chilled Water Supply Temperature: After a chiller is started and after a sufficient time delay of approximately 10 min. (reprogrammable), integral chiller control panel microprocessor PID control loop of the chiller shall receive an input from the BAS for modulation of chiller capacity to maintain 42.0°F (reprogrammable) primary chilled water supply temperature at the common "master" chilled water supply in the common discharge piping header.
 - a. Chilled water temperature reset through internal chiller controls based on the following parameters:
 1. 43 deg F (adjustable) chilled water supply at 70 deg F dewpoint (88 deg F DB, 73 deg F WB)
 2. 46 deg F (adjustable) chilled water supply at 1 deg F dewpoint (16 deg F DB, 13 deg F WB)

5. For any “activated” chiller to shut down in sequence, all of the following requirements must occur:
 - a. Associated BAS start/stop contact (digital output) to unit-mounted control panel and compressor motor starter shall open to allow chiller to begin and complete manufacturer’s shut down sequence programmed into the chiller control panel.
 - b. Immediately after deactivation of the chiller (manufacturer’s shut down sequence is complete), the associated chilled water pump will be stopped through start digital output from BAS.
 - c. Chilled water flow rate through the chiller will then be proven to be steadily falling as monitored from a differential sensor /transmitter installed in local cooler piping connections across chiller.
 - d. Immediately after deactivation of the chiller, the associated condenser water pump shall be stopped through starter digital output from and status digital input to BAS and the lead cooling tower water piping circulation sub-system will be deactivated.
 - e. Condenser water flow rate through the chiller will then be proven to be steadily falling by analog input from differential pressure sensor/transmitter installed in condenser piping connections across chiller.
 - f. Upon shutdown of any chiller, the unit’s condenser and evaporator isolation valve’s will remain open for manufacturer suggested “purge time” (default 5 min. adjustable) and subsequently long enough for circuit pumps to coast down.
 - g. If status for any chiller isolation valve fails to match the command, a corresponding alarm shall be generated and annunciated at the BAS.
6. Staging /Operation:
 - a. Upon the failure of the lead chiller or site load requiring an additional chiller, the secondary chiller with the highest priority shall be the chiller with the least amount of runtime, cascading in order by ascending runtime. The secondary chiller’s condenser and the evaporator isolation valve shall be indexed open and upon confirmation of open status chilled pump circuits are enabled and the respective circuit lead duty pump commanded to run.
 - b. Chiller Plant Equipment (Chillers / Pumps / Cooling Towers) operation shall rotate every 3 weeks (adjustable) to maintain equal equipment runtime.
 - c. Increase in load
 1. The primary chilled water pumps provide the required, constant volume flow for each chiller. The secondary pumps draw from and return water from that loop. The decoupler loop (the common piping for both the primary and secondary loops). When the number of operating chillers is adequate for the secondary flow, the decoupler loop flow is from the chiller supply to the chiller return. As the load increases, the decoupler flow will decrease until the primary flow is equal to the secondary loop flow and the decoupler flow will be zero. On a continued load increase, the secondary variable volume pumps will exceed the primary loop capacity and flow will reverse in the decoupler loop. This reversal of water flow in the decoupler loop or a rise in secondary supply water temperature shall be the signal to energize an additional chiller.
 - d. Decrease in Loads:
 1. On a fall in return water temperature to the point where the required load can be handled by one less chiller; a chiller, chilled water and condenser water pump shall be deenergized.
 2. The program shall select the chiller and pumps with the most run time.

3. Incorporated programming tuning which shall begin to close the isolation valve and deenergizing a pump shall not cause a drop in operating chiller flow to cause safety shutdown.
- e. Primary Chiller Pumping Controls
1. When chiller plant operation is enabled, the respective primary and secondary chilled water pumps with the least accumulated runtime will be ranked as the circuit's lead duty unit. When the respect chiller is enabled, the intended pump operation shall soft start through the VFD and ramp up to constant volume operation.
 2. If a pump status fails to match the pump the pump's commanded state an associated pump failure alarm will be generated and annunciated at the BAS.
 3. A pump failure event will cause the associated circuit's pump control to start the next ranked pump in it's duty rotation in place of the failed pump. A manual operator-initiated pump software maintenance switch command, when indexed through the BAS interface, will disable the respective pump, effectively removing it from the pump circuit's duty rotation passing control on to the next available pump.
 4. Pump runtime equalization function is accomplished through runtime rotation of pump control in response to plant load variation during operations. When the chiller plant is in active operation with chiller(s) and pumps running, chilled water and condenser water pump lead duty assignments may be manually switched through a BAS operator-initiated software maintenance switch manual command via the ROTATE NOW input.
 5. The manual pump duty rotation operation is intended for periods with scheduled on duty plant operators rather than via automated runtime interval initiated command alone and will initiated if the rotation is required at that time.
 6. Upon shutdown the commanded pump will be permitted to continue running over an adjustable delay time to allow the served equipment to coast down.
- f. Secondary Chiller Water Control
1. A differential pressure transmitter shall be installed in each main header as shown on the chilled water diagram. All transmitters shall be wired to the controller sending the VFD signal to the secondary pump drives, and the pump[s] shall be controlled to maintain the lowest loop sensed loop pressure.
- g. Condenser Water System Operation
1. Condenser Water System: The six cooling towers are each equipped with 2 sets of 4 fans with a variable frequency drive and status per tower. The towers shall sequence with one per Chiller.
 2. The cooling tower fans' variable frequency drives are controlled to maintain a condenser supply water temperature set point adjustable to the two adjustable reset setpoint schedules based on outside air wet bulb temperature:
 3. 85°F (adjustable) condenser EWT at 78°Fwb
 4. 40°F (adjustable) condenser EWT at 30°Fwb.
 5. Minimum design condenser EWT shall be 36°F
 6. If any tower fan (set) status does not match the command, an alarm shall be generated, annunciated at the BAS.
 7. The system configuration does not include a tower bypass valve circuit; during single tower operation in the event fans have modulated to minimum speed and the condenser water supply temperature fall below the condenser

supply water temperature minimum the tower fan set shall be indexed off as required to maintain the condenser water temperature.

8. When the Condenser Water System is enabled, one of the four towers (1 future) shall start with its fans initiating at minimum speed.
9. Upon an increase in condenser water temperature fans shall modulate towards maximum as required, with continued rise in temperature additional towers shall start, upon a decrease in temperature the control will reverse.
10. The active tower's isolation valve shall be commanded open prior to starting the pump. Upon shutdown the tower isolation valve shall be kept open long enough for the pump to coast down.

h. Condenser Water Pumping Controls

1. When chiller plant operation is enabled, the respected condenser water circuit pump with the least accumulated runtime will be ranked as the circuit's lead duty unit.
2. Upon enable the current lead duty condenser circuit pump shall be started and operate to its indexed speed setting as determined by TAB. If a pump status fails to match the pump's commanded state an associated pump failure alarm will be generated and annunciated at the BAS.
3. A pump failure event will cause the associated circuit's pump control to start the next ranked pump in it's duty rotation in place of the failed pump. A manual operator-initiated pump software maintenance switch command, when indexed through the BAS interface, will disable the respective pump, effectively removing it from the pump circuit's duty rotation passing control on to the next available pump.
4. Pump runtime equalization function is accomplished through runtime rotation of pump control in response to plant load variation during operations. When the chiller plant is in active operation with chiller(s) and pumps running, condenser water pump lead duty assignments may be manually switched through a BAS operator-initiated software maintenance switch manual command via the ROTATE NOW input.
5. The manual pump duty rotation operation is intended for periods with scheduled on duty plant operators rather than via automated runtime interval-initiated command alone and will initiate if the rotation is required at that time.
6. Upon shutdown the commanded pump will be permitted to continue running over an adjustable delay time to allow the served equipment to coast down.

7. Cooling Tower

- a. Cooling Tower Safety Circuit Through Fan VFD – The safety circuit consists of a micro switch at the fan disconnect at the cooling tower. If contact opens, power to the fan motor is shut off and the fan will stop rotating. A safeties alarm shall display for the respective fan at the BAS Workstation.
- b. Electric Basin Heaters – The cooling tower shall be supplied with electric basin heaters and local thermostats. The electric basin heater(s) shall energize upon a drop in basin temperature below 40 deg F (reprogrammable). A temperature sensor shall be mounted by the BAS contactor for low temperature alarm. An alarm shall be generated at the BAS Workstation upon a fall in basin temperature below 36 deg F (reprogrammable).
- c. Basin Water Level Monitoring: The BAS shall continuously monitor/alarm basin water levels through ultrasonic liquid level transmitters. Upon transmitter sensing

water levels below/above the low/high limit settings, an alarm shall be generated at the BAS Workstation. A generated cooling tower basin water level alarm shall also result in shut down of the cooling tower and alarm the associated chiller, chilled water and condenser water pumps (prior to reassignment of Lead/Lag/Spare).

- d. Cooling Tower Water Temperature Control
 1. Provide a temperature sensor in the condenser water going to the chiller. In the event the water temperature is below 65°F (reprogrammable) the tower bypass valve shall be open and the tower valve shall be closed. As the water warms up, the bypass and tower valves shall modulate until all the water follows over the tower. Tower water full flow shall continue unless there is a fall in temperature to 65°F (reprogrammable). In the event the tower water temperature begins to rise, the operating cooling tower fans shall be modulated and cycled in sequence to maintain the chiller manufacturers maximum (and minimum for water side economizer operation) recommended entering condenser water temperature.
 2. Provide differential pressure switch across pump which shall detect pump flow. Whenever there is no pump flow, tower valve shall open to bypass tower and fans shall be inhibited from being energized.
8. Chilled Water Plant Refrigerant Leak Detection System
 - a. The refrigerant leak detection system provides an alarm contact to the BAS. The refrigerant level in the chiller room shall be continuously monitoring and alarmed upon sensing a high level of refrigerant.'
 - b. The refrigerant purge exhaust fan serving the chiller room shall start upon reaching a high level of refrigerant. See chiller exhaust fan control.
 - c. Audible and visual alarms shall be annunciated at each entrance of the chiller room.
 - d. Refrigerant high and low level alarms shall be manually reset at the monitor panel.
 - e. Upon an alarm condition the hot water boilers and associated hot water pumps shall be disabled. Heating hot water shall be generated through plate and frame heat exchangers located in the level 1 MER.
9. Chiller Room Ventilation Unit General
 - a. During normal operation, ERV-1 shall pretreat outdoor air. An electric preheat coil has been provided for this unit for to allow for preheat. A remote coil module has been provided for additional conditioning of pretreated outdoor air. Outside air intake dampers and room high and low exhaust air dampers have been provided. The low exhaust air damper(s) shall be normally open (fail safe operated as open damper).
10. Provide a space sensor which shall generate an alarm at the BAS workstation when the room temperature is below 55 deg F or above 85 deg F.
11. Exhaust Mode – On a signal from the refrigerant monitoring panel, the outside air damper and exhaust damper associated with ERV-1 shall close, the chiller room purge outside air damper shall fully open, the low dampers shall open, the high dampers shall close and the exhaust fan shall be energized.

B. Heating Hot Water System

1. General
 - a. The heating water system consists of five (1 future) gas-fired condensing boilers with constant flow primary pumps and configured in a lead/lag arrangement with variable speed secondary hot water pumps in a lead/spare arrangement.
 - b. The heating water system shall be enabled through the DDC system.

- c. The boilers shall be automatically rotated on either failure or based on a weekly schedule to distribute runtime evenly between all hot water boilers.
 - d. Hot water capacity shall be supplemented by three plate and frame steam to hot water heat exchangers which are sized to provide full heating plant capacity when boilers are not able to operate (boiler failure, natural gas unavailable, chiller room refrigerant detection.)
- 2. Boiler Control
 - a. The boilers will be provided with packaged microprocessor controls to control boiler discharge temperature at 180° F (reprogrammable through communications card) when enabled by the BAS.
 - b. Boiler operation and lead/lag sequencing shall be optimized and controlled through the integral boiler control panel furnished with the boiler package.
 - c. The heating water system shall be enabled through the BAS. When enabled, the BAS shall start open the lead boiler isolation valve and then start the lead pump. Once minimum flow is established, as indicated by a differential pressure sensor, the lead boiler shall be enabled. The lead pump shall remain energized whenever heating system is enabled.
 - d. The boilers shall be automatically rotated on either failure or based on a weekly schedule to distribute runtime evenly between all boilers.
 - e. The heating water differential bypass shall be modulated to maintain minimum boiler and pump flow as sensed by a differential pressure sensor located at the lead boiler.
- 3. Hot Water Pump Control
 - a. The lead hot water pump shall run whenever the hot water system is enabled.
 - a. The BAS shall modulate the pump's variable frequency drive to maintain heating hot system differential pressure at set point (reprogrammable).
 - b. Upon failure of the lead pump, an alarm shall notify the DDC system and the spare pump shall be energized.
 - c. The lead and spare pump assignments shall be rotated weekly in order to equalize pump run times. A current sensor for each pump shall provide status indication to the DDC for failure alarm and accumulation of run time.
 - d. VFD Control
 - 1. As differential pressure deviates from set point, system controller shall send the appropriate analog signal to the VFD to speed up or slow down the pump motor.
 - 2. In event of failure to receive the zone system variable signal, VFD shall maintain 100% speed, unless otherwise required for end of curve protection; reset shall be automatic upon correction of the failure.
- 4. Safeties:
 - a. Pump Status: A current switch for each pump shall provide status indication at the Operator Workstation for pump failure alarm and accumulation of runtime. In the event of a pump failure, the BAS shall de-energize the failed pump and start the spare pump, and indicate an alarm at the Operator Workstation.
 - b. BAS shall monitor boiler alarms through the boiler's control panel.
 - c. Emergency burner shutdown switches shall be installed at each exit location from the boiler room and be wired into each boiler's safety circuit.

C. Steam to Hot Water Heat Exchanger

- 1. Three steam to hot water heat exchangers are provided for supplemental heating hot water capacity and to serve as a fully redundant backup to the boiler plant.

2. Provide sensor in hot water supply piping and outside air sensor. Locate outside air sensor on north wall at least 10 feet above grade and provide a sunshield.
 3. DDC system shall modulate 2 normally closed steam valves in sequence to maintain an adjustable reset schedule. Select valves for one-third and two-thirds of total capacity. Note: One-third and two-thirds of total capacity is design and actual split will be a ratio of each valves CV to the total CV,
 4.

OA Temp	Hot Water Supply Temp. (Adj.)
0 deg F	180 deg F
60 deg F	160 deg F
 5. Redundant primary circulation pumps shall be provided for heat exchanger service.
 6. The heat exchangers and pumps shall be automatically rotated on either failure or based on a weekly schedule to distribute runtime evenly between all heat exchangers.
 7. A differential pressure transmitter shall be installed in the main header as shown on the diagrams. All transmitters shall be wired to the controller sending the VFD signal to the pump drives, and the pump[s] shall be controlled to maintain the lowest loop sensed.
- D. AHU Control (AHUs-1-1 thru 1-6, 4-7 thru 4-9, and 4-10 and 4-12, Level 1 and Level 4 MERs)
1. General
 - a. AHUs-4 AHUs-1-1 thru 1-6, 4-7 thru 4-9, and 4-12 are located in the 1st and 4th floor MERs of the new patient tower. AHU components include variable speed supply and return fans, hot water preheat coil, chilled water cooling coil with UV light, humidifier, economizer section, and filtration (MERV 8, MERV 14). Unit runs continuously and is started and stopped manually through the DDC system.
 2. Startup and Fan Shutdown
 - a. When unit is indexed to start, outside air and smoke dampers shall open and end switches shall energize fans. Interlocked exhaust fans shall be energized.
 - b. Whenever fan is deenergized, outside air damper closes, smoke dampers close, humidifier valve closes, and preheat valves remain under control. Dampers shall be controlled to maintain 70 deg F in the mixing box.
 - c. Provide slow opening signal to outside air damper to prevent nuisance shutdowns during startup.
 - d. Whenever dampers close, there shall be a time delay to allow for fan spindown.
 3. Occupied Control
 - a. A signal from DDC controller shall index system to occupied mode
 - b. Minimum Outside air damper shall open
 - c. Temperature
 1. A supply air sensor through the DDC system shall on a rise in temperature first modulate the preheat coil valve closed, then modulate outdoor air damper open and return damper closed, then modulate cooling coil valve to maintain setpoint (Adjustable).
 2. A preheat coil discharge air temperature sensor through DDC system shall, on a drop in temperature, first close outside air damper (to minimum) and then modulate open preheat coil valve. Preheat coil low limit discharge air temperature sensor shall prevent discharge air from falling below its setting (initially set at 50 deg F).
 - d. Humidity: Return air humidity sensors through the DDC system shall modulate humidifier valve to maintain 20% relative humidity (adjustable). A supply air humidity sensor shall override and prevent supply air humidity from rising above its

setpoint of 85% relative humidity. High limit humidistats shall be fully modulating. Whenever fan is deenergized, humidifier valves shall be closed.

- e. Pressure:
 - 1. A static pressure sensor in the return fan discharge plenum shall modulate open the relief air damper to maintain its setting.
 - 2. A static pressure sensor located 2/3 down supply duct shall, through the DDC System, modulate variable frequency drive to maintain duct static pressure of 1.2 inches (reprogrammable).
 - 3. A discharge high limit and inlet low limit static pressure sensor shall override supply duct static control and prevent over pressuring or under pressurizing of system.
 - 4. A discharge high limit and inlet low limit static pressure sensor shall override return fan speed control and prevent over pressuring or under pressurizing of system.
 - 5. Supply and return air flow quantities shall be measured at the inlet of each fan and return fan variable frequency drive shall be controlled to maintain constant CFM differential.
- f. Fan Array:
 - 1. Supply and return fan arrays are provided with a variable speed control panel. Provide interface with this panel. The variable speed control panels include two controllers (primary and back-up), local transfer switch and individual disconnects for each fan. Provide current switch monitoring of each fan and each variable speed control panel. Provide control interface to allow for automatic switchover from primary to back-up variable speed controller upon failure of primary variable speed controller. Allow DDC selection of primary and back-up variable speed controller. Provide alternative of variable speed control panel every two weeks or when system is shut down. Provide variable speed controller failure indication at the DDC.
 - 2. All fans shall operate together.
 - 3. Upon failure or shutdown of a single fan, the remaining fans shall ramp up to achieve the control setpoint.
 - 4. Variable speed control shall be modulated as indicated in this section.
 - 5. Provide all safety and interlock controls as indicated in this section.
- g. Economizer Section
 - 1. Economizer dampers shall be utilized for smoke purge modes of operation only.
 - 2. Economizer Section:
 - a) Outdoor air, return air, and relief air dampers shall be independently controlled.
- h. Post Smoke Purge Mode
 - 1. Purge Mode may be enabled or disabled at Fire Command Center and BAS Workstation.
 - 2. Whenever AHU is operating in (Smoke) Purge Mode, supply and return air fan(s) shall be energized, outside air, relief air, bypass/economizer damper opens. Return damper shall remain closed. Return fan(s) continues to operate, and wheel shall be de-energized.
 - 3. Signals to start/stop AHU and smoke dampers at shaft openings at floors are by Division 28.

4. When AHU is operating in Purge Mode, an alarm shall be generated at the BAS Workstation.
 4. Safety Controls
 - a. Low temperature limit thermostat shall deenergize fans and alarm the DDC System.
 - b. Supply and Return fan status shall be monitored through current sensors and alarmed to the DDC System.
 - c. Supply fan static pressure sensor shall, through the DDC system, de-energize fans and alarm DDC system in case of excessive static pressure (greater than 5 in w.g. positive).
 - d. Return fan static pressure sensor shall, through the DDC system, de-energize fans and alarm DDC system in case of excessive negative pressure (greater than 4 in w.g. negative).
 - e. When current switches indicate a fan failure an alarm shall be indicated at the Operator Workstation.
 - f. Fan status shall be monitored through a current sensor and be alarmed to the Operator Workstation if fan is not energized when commanded.
 - g. The DDC system shall monitor VFD alarms.
 - h. A differential pressure switch provided for each filter bank shall alarm the DDC System.
 - i. Smoke detectors in the supply and return air duct shall through interface modules deenergize fans.
 5. Input/Output Requirements
 - a. Provide input/output points as shown on the control diagram. Any additional points required for the above sequence of operation shall be provided and be used for DDC alarm/monitoring.
 - b. Provide monitoring and alarms for the following:
 1. Variable Speed Controller Failure
 2. High/Low Fan CFM
 3. High/Low Static Pressure
 4. Freeze Stat Trip
 5. Fire Alarm Shutdown
 6. High/Low Discharge Air Temperature
 7. High/Low Return Air Temperature
 8. High/Low Return Air Humidity
 9. Low Mixed Air Temperature Alarm
 10. Filter Status Alarm (Prefilter / Final Filter)
 11. Fan Status and Failure
 12. Energy Recovery Wheel
 13. Water Leak Detection Alarms
 14. Cooling Coil Return Water Temperature
 15. Preheat Coil Return Water Temperature
 16. Damper Position (Monitoring Only – Outdoor Min and Max / Return / Exhaust)/
- E. AHU Control (AHUs-4-11, 10-1 thru 10-4, Level 4 and 10 MER)
 1. General
 - a. AHUs-4-11, and 10-1 thru 10-4 are located in the 4th and 10th floor MERs of the new patient tower. AHU components include variable speed supply and return fans, hot water preheat coil, chilled water cooling coil with UV light, humidifier, economizer

- section, and filtration (MERV 8, MERV 16). Unit runs continuously and is started and stopped manually through the DDC system.
2. Startup and Fan Shutdown
 - a. When unit is indexed to start, outside air and smoke dampers shall open and end switches shall energize fans. Interlocked exhaust fans shall be energized.
 - b. Whenever fan is deenergized, outside air damper closes, smoke dampers close, humidifier valve closes, and preheat valves remain under control. Dampers shall be controlled to maintain 70 deg F in the mixing box.
 - c. Provide slow opening signal to outside air damper to prevent nuisance shutdowns during startup.
 - d. Whenever dampers close, there shall be a time delay to allow for fan spindown.
 3. Occupied Control
 - a. A signal from DDC controller shall index system to occupied mode
 - b. Minimum Outside air damper shall open
 - c. Temperature
 1. A supply air sensor through the DDC system shall on a rise in temperature first modulate the preheat coil valve closed, then modulate outdoor air damper open and return damper closed, then modulate cooling coil valve to maintain setpoint (Adjustable).
 2. A preheat coil discharge air temperature sensor through DDC system shall, on a drop in temperature, first close outside air damper (to minimum) and then modulate open preheat coil valve. Preheat coil low limit discharge air temperature sensor shall prevent discharge air from falling below its setting (initially set at 50 deg F).
 - d. Humidity: Return air humidity sensors through the DDC system shall modulate humidifier valve to maintain 20% relative humidity (adjustable). A supply air humidity sensor shall override and prevent supply air humidity from rising above its setpoint of 85% relative humidity. High limit humidistats shall be fully modulating. Whenever fan is deenergized, humidifier valves shall be closed.
 - e. Pressure:
 1. A static pressure sensor in the return fan discharge plenum shall modulate open the relief air damper to maintain its setting.
 2. A static pressure sensor located 2/3 down supply duct shall, through the DDC System, modulate variable frequency drive to maintain duct static pressure of 1.2 inches (reprogrammable).
 3. A discharge high limit and inlet low limit static pressure sensor shall override supply duct static control and prevent over pressuring or under pressurizing of system.
 4. A discharge high limit and inlet low limit static pressure sensor shall override return fan speed control and prevent over pressuring or under pressurizing of system.
 5. Supply and return air flow quantities shall be measured and return fan variable frequency drive shall be controlled to maintain constant CFM differential.
 - f. Fan Array:
 1. Supply and return fan arrays are provided with a variable speed control panel. Provide interface with this panel. The variable speed control panels include two controllers (primary and back-up), local transfer switch and individual disconnects for each fan. Provide current switch monitoring of each fan and each variable speed control panel. Provide control interface to allow for

- automatic switchover from primary to back-up variable speed controller upon failure of primary variable speed controller. Allow DDC selection of primary and back-up variable speed controller. Provide alternative of variable speed control panel every two weeks or when system is shut down. Provide variable speed controller failure indication at the DDC.
2. All fans shall operate together.
 3. Upon failure or shutdown of a single fan, the remaining fans shall ramp up to achieve the control setpoint.
 4. Variable speed control shall be modulated as indicated in this section.
 5. Provide all safety and interlock controls as indicated in this section.
- g. Economizer Section
1. Economizer dampers shall be utilized for smoke purge and pandemic modes of operation only.
 2. Outdoor air, return air, and relief air dampers shall be independently controlled.
 3. A mixed air low limit temperature sensor through the DDC system shall, on a drop in temperature below 40 deg F (adjustable) when AHU is operating in pandemic mode, Provide status alarm at the BAS.
- h. Pandemic Mode
1. Pandemic Mode may be enabled or disabled at BAS Workstation only.
 2. Whenever AHU is operating in Pandemic Mode, supply and return air fan(s) shall be energized, outside air, relief air, and return air dampers shall be adjusted to allow for additional makeup air to patient floors. AHUs shall operate to maintain occupied temperature and humidity set points.
 3. When AHU is operating in Pandemic Mode, an alarm shall be generated at the BAS Workstation.
- i. Post Smoke Purge Mode
1. Purge Mode may be enabled or disabled at Fire Command Center and BAS Workstation.
 2. Whenever AHU is operating in (Smoke) Purge Mode, supply and return air fan(s) shall be energized, outside air, relief air, bypass/economizer damper opens. Return damper shall remain closed. Return fan(s) continues to operate, and wheel shall be de-energized.
 3. Signals to start/stop AHU and smoke dampers at shaft openings at floors are by Division 28.
 4. When AHU is operating in Purge Mode, an alarm shall be generated at the BAS Workstation.
4. Safety Controls
- a. Low temperature limit thermostat shall deenergize fans and alarm the DDC System.
 - b. Supply and Return fan status shall be monitored through current sensors and alarmed to the DDC System.
 - c. Supply fan static pressure sensor shall, through the DDC system, de-energize fans and alarm DDC system in case of excessive static pressure (greater than 5 in w.g. positive).
 - d. Return fan static pressure sensor shall, through the DDC system, de-energize fans and alarm DDC system in case of excessive negative pressure (greater than 4 in w.g. negative).
 - e. When current switches indicate a fan failure an alarm shall be indicated at the Operator Workstation.
 - f. Fan status shall be monitored through a current sensor and be alarmed to the Operator Workstation if fan is not energized when commanded.

- g. The DDC system shall monitor VFD alarms.
 - h. A differential pressure switch provided for each filter bank shall alarm the DDC System.
 - i. Smoke detectors in the supply and return air duct shall through interface modules deenergize fans.
 - 5. Input/Output Requirements
 - a. Provide input/output points as shown on the control diagram. Any additional points required for the above sequence of operation shall be provided and be used for DDC alarm/monitoring.
 - b. Provide monitoring and alarms for the following:
 - 1. Variable Speed Controller Failure
 - 2. High/Low Fan CFM
 - 3. High/Low Static Pressure
 - 4. Freeze Stat Trip
 - 5. Fire Alarm Shutdown
 - 6. High/Low Discharge Air Temperature
 - 7. High/Low Return Air Temperature
 - 8. High/Low Return Air Humidity
 - 9. Low Mixed Air Temperature Alarm
 - 10. Filter Status Alarm (Prefilter / Final Filter)
 - 11. Fan Status and Failure
 - 12. Energy Recovery Wheel
 - 13. Water Leak Detection Alarms
 - 14. Cooling Coil Return Water Temperature
 - 15. Preheat Coil Return Water Temperature
 - 16. Damper Position (Monitoring Only – Outdoor Min and Max / Return / Exhaust)/
- F. AHU Control (AHU-5-1, Level 5 Roof)
- 1. General
 - a. AHU-5-1 is an outdoor unit located on the level 5 roof of the new patient tower. AHU components include variable speed supply and return fans, hot water preheat coil, chilled water cooling coil with UV light, economizer section, and filtration (MERV 8, MERV 14). Unit runs continuously and is started and stopped manually through the DDC system.
 - 2. Startup and Fan Shutdown
 - a. When unit is indexed to start, outside air and smoke dampers shall open and end switches shall energize fans. Interlocked exhaust fans shall be energized.
 - b. Whenever fan is deenergized, outside air damper closes, smoke dampers close, humidifier valve closes, and preheat valves remain under control. Dampers shall be controlled to maintain 70 deg F in the mixing box.
 - c. Provide slow opening signal to outside air damper to prevent nuisance shutdowns during startup.
 - d. Whenever dampers close, there shall be a time delay to allow for fan spindown.
 - 3. Occupied Control
 - a. A signal from DDC controller shall index system to occupied mode
 - b. Minimum Outside air damper shall open
 - c. Temperature
 - 1. A supply air sensor through the DDC system shall on a rise in temperature first modulate the preheat coil valve closed, then modulate outdoor air damper

- open and return damper closed, then modulate cooling coil valve to maintain setpoint (Adjustable).
2. A preheat coil discharge air temperature sensor through DDC system shall, on a drop in temperature, first close outside air damper (to minimum) and then modulate open preheat coil valve. Preheat coil low limit discharge air temperature sensor shall prevent discharge air from falling below its setting (initially set at 50 deg F).
- d. Pressure:
1. A static pressure sensor in the return fan discharge plenum shall modulate open the relief air damper to maintain its setting.
 2. A static pressure sensor located 2/3 down supply duct shall, through the DDC System, modulate variable frequency drive to maintain duct static pressure of 1.2 inches (reprogrammable).
 3. A discharge high limit and inlet low limit static pressure sensor shall override supply duct static control and prevent over pressuring or under pressurizing of system.
 4. A discharge high limit and inlet low limit static pressure sensor shall override return fan speed control and prevent over pressuring or under pressurizing of system.
 5. Supply and return air flow quantities shall be measured at the inlet of each fan and return fan variable frequency drive shall be controlled to maintain constant CFM differential.
- e. Fan Array:
1. Supply and return fan arrays are provided with a variable speed control panel. Provide interface with this panel. The variable speed control panels include two controllers (primary and back-up), local transfer switch and individual disconnects for each fan. Provide current switch monitoring of each fan and each variable speed control panel. Provide control interface to allow for automatic switchover from primary to back-up variable speed controller upon failure of primary variable speed controller. Allow DDC selection of primary and back-up variable speed controller. Provide alternative of variable speed control panel every two weeks or when system is shut down. Provide variable speed controller failure indication at the DDC.
 2. All fans shall operate together.
 3. Upon failure or shutdown of a single fan, the remaining fans shall ramp up to achieve the control setpoint.
 4. Variable speed control shall be modulated as indicated in this section.
 5. Provide all safety and interlock controls as indicated in this section.
- f. Economizer Section
1. Economizer dampers shall be utilized for post smoke purge mode of operation only.
 2. Outdoor air, return air, and relief air dampers shall be independently controlled.
- g. Post Smoke Purge Mode
3. Purge Mode may be enabled or disabled at Fire Command Center and BAS Workstation.
 4. Whenever AHU is operating in (Smoke) Purge Mode, supply and return air fan(s) shall be energized, outside air, relief air, bypass/economizer damper opens. Return damper shall remain closed. Return fan(s) continues to operate, and wheel shall be de-energized.

5. Signals to start/stop AHU and smoke dampers at shaft openings at floors are by Division 28.
6. When AHU is operating in Purge Mode, an alarm shall be generated at the BAS Workstation.
4. Safety Controls
 - a. Low temperature limit thermostat shall deenergize fans and alarm the DDC System.
 - b. Supply and Return fan status shall be monitored through current sensors and alarmed to the DDC System.
 - c. Supply fan static pressure sensor shall, through the DDC system, de-energize fans and alarm DDC system in case of excessive static pressure (greater than 5 in w.g. positive).
 - d. Return fan static pressure sensor shall, through the DDC system, de-energize fans and alarm DDC system in case of excessive negative pressure (greater than 4 in w.g. negative).
 - e. When current switches indicate a fan failure an alarm shall be indicated at the Operator Workstation.
 - f. Fan status shall be monitored through a current sensor and be alarmed to the Operator Workstation if fan is not energized when commanded.
 - g. The DDC system shall monitor VFD alarms.
 - h. A differential pressure switch provided for each filter bank shall alarm the DDC System.
 - i. Smoke detectors in the supply and return air duct shall through interface modules deenergize fans.
5. Input/Output Requirements
 - a. Provide input/output points as shown on the control diagram. Any additional points required for the above sequence of operation shall be provided and be used for DDC alarm/monitoring.
 - b. Provide monitoring and alarms for the following:
 1. Variable Speed Controller Failure
 2. High/Low Fan CFM
 3. High/Low Static Pressure
 4. Freeze Stat Trip
 5. Fire Alarm Shutdown
 6. High/Low Discharge Air Temperature
 7. High/Low Return Air Temperature
 8. High/Low Return Air Humidity
 9. Low Mixed Air Temperature Alarm
 10. Filter Status Alarm (Prefilter / Final Filter)
 11. Fan Status and Failure
 12. Energy Recovery Wheel
 13. Water Leak Detection Alarms
 14. Cooling Coil Return Water Temperature
 15. Preheat Coil Return Water Temperature
 16. Damper Position (Monitoring Only – Outdoor Min and Max / Return / Exhaust)

G. Air Volume Control Box Schemes

1. All Control Schemes: Control Contractor shall coordinate with box manufacturer and provide all necessary materials and field work to connect control components factory

supplied as part of various variable air volume control box schemes in order for them to operate as described.

2. Control Scheme 1 (VAV Box Only)
 - a. VAV Boxes: Provide a space sensor (or return air sensor where indicated) which shall on a fall in temperature modulate VAV box airflow rate to its scheduled minimum. On a continued fall after the box has reached scheduled minimum air flowrate, after the dead band, the reheat valve shall be modulated to maintain space temperature.
 - b. For boxes that have associated CO2 sensors, modulate damper open whenever CO2 level exceeds 800 PPM (reprogrammable).
3. Control Scheme 2 (Single VAV Box with Finned Tube Radiation)
 - a. VAV Boxes: Provide a space sensor (or return air sensor where indicated) which shall on a fall in temperature modulate VAV box airflow rate to its scheduled minimum. On a continued fall after the box has reached scheduled minimum airflow, after the dead band, the reheat valve shall be modulated to maintain space temperature.
 - b. After the reheat coil valve has modulated to full open, and on a continued fall in space temperature, modulate the finned tube radiation control valve to maintain space temperature.
 - c. For boxes that have associated CO2 sensors, modulate damper open whenever CO2 level exceeds 800 PPM (reprogrammable).
4. Control Scheme 3 (Multiple VAV Boxes with Single Finned Tube Radiation Zone)
 - a. VAV Boxes: Control VV box airflow and reheat coil control valve as noted above.
 - b. After 2 minutes (adjustable) or more of the reheat coil valves associated with the finned tube zone have modulated to full open, and on a continued fall in space temperature, modulate the finned tube radiation control valve to maintain space temperature.
 - c. For boxes that have associated CO2 sensors, modulate damper open whenever CO2 level exceeds 800 PPM (reprogrammable).
5. Control Scheme 4 (Tracking Controls, other than operating rooms)
 - a. Supply VAV Boxes: Provide a space sensor which shall on a fall in temperature modulate VAV box airflow rate to its scheduled minimum. On a continued fall after the box has reached scheduled minimum flow, after the dead band, the reheat valve shall be modulated to maintain space temperature.
 - b. Return/Exhaust VAV Boxes: Modulate VAV box airflow rate to maintain scheduled fixed differential airflow rate.
6. Control Scheme 5 (Operating Room Tracking Controls)
 - a. Supply VAV Boxes (Occupied): Provide a space sensor which shall on a fall in temperature modulate VAV box airflow rate to its scheduled minimum. On a continued fall after the box has reached scheduled minimum flow, after the dead band, the reheat valve shall be modulated to maintain space temperature.
 - b. Return/Exhaust VAV Boxes: Modulate VAV box airflow rate to maintain scheduled fixed differential airflow rate.
 - c. Supply VAV Boxes (Unoccupied): During the scheduled unoccupied timeframe (adjustable), reduce supply airflow rate to the greater of 10 air changes per hour and the fixed differential airflow rate. A signal from either of the occupancy sensors shall resume normal occupied operation as described above.

H. Duct Smoke Damper and Combination Fire/Smoke Damper Control

1. Unless otherwise specified, duct smoke dampers and combination duct fire/smoke dampers shall close when respective unit is deenergized or operate as specified herein.

2. Air Handling Units with Supply and Return Smoke Dampers
 - a. When unit is energized, AHU isolation supply and return air smoke dampers open, end switches energize fans.
 - b. Combination fire/smoke dampers throughout system also open.
 - c. Any time fan is deenergized, all smoke and fire/smoke dampers close after time delay for fan spindown.
 - d. Detection of smoke at a duct mounted, non-isolation, smoke or fire/smoke damper carrying less than 50% of the system airflow rate shall only close that damper, the other dampers in the system shall remain open
 3. Exhaust System Serving One Zone. Upon detection of smoke, fan shall continue to run.
 4. Exhaust System Serving Multiple Zones and Separate Exhaust Ducts
 - a. Upon detection of smoke, fire/smoke damper shall close for smoke zone only. Other zones remain open and fan continues to run.
 - b. A static pressure sensor in exhaust fan suction shall deenergize fan when its setpoint is exceeded.
 - c. When fan is deenergized, after a time delay for fan spindown, all smoke and combination fire/smoke dampers close.
 5. Exhaust System Serving Multiple Zones with Common Exhaust Ducts. Upon detection of
 1. smoke, exhaust fan shall be deenergized, and after a time delay for fan spindown, all smoke and fire/smoke dampers close.
- I. Exhaust Fan Control - Isolation
1. Exhaust fans run continuously. Provide a stop/start signal from the Operator Workstation and status monitoring.
 2. Provide a duct mounted static pressure transmitter located 2/3 of the way down the longest run and arranged, through the DDC controller, to signal the VFD to speed up on a drop in duct static. The reverse shall occur on a rise in duct static. Initial setpoint shall be 1.0" S.P. (adj). Provide a low fan inlet S.P. switch arranged to stop the fan to prevent under pressure at the duct system.
 3. Interlock smoke detector/smoke damper as indicated on the smoke damper/detector schedule.
 4. Provide bag-in/bag-out filter monitoring.
- J. Exhaust Fan Control - General
1. Exhaust fans run continuously. Provide a stop/start signal from the Operator Workstation and status monitoring.
 2. Interlock smoke detector/smoke damper as indicated on the smoke damper/detector schedule.
- K. Kitchen Exhaust Fans (Hot Production, Play Tray Plating) – Hood Manufacturer Controller (KEF-5-1, KEF-5-2)
1. Hood manufacturer will provide control panel and VFDs, which will operate fans at varying percentages. Provide BACNet electronic interface with hood manufacturer's panel.
 2. Provide signal to Hood Manufacturer's controller to energize kitchen exhaust fans in "prep mode" when space temperature exceeds setpoint.
 3. Provide exhaust fan status at BAS workstation.
- L. Kitchen Exhaust Fans (Serving) – Hood Manufacturer Controller (KEF-5-3)

1. Hood manufacturer will provide control panel and VFDs, which will operate fans at varying percentages. Provide BACNet electronic interface with hood manufacturer's panel.
 2. Provide signal to Hood Manufacturer's controller to energize kitchen exhaust fans in "prep mode" or when cooking equipment is energized and when space temperature exceeds setpoint.
 3. Provide exhaust fan status at BAS workstation.
- M. Dishwashing / Pot Washing Exhaust Fans (KEF-10-1 and KEF 10-2)
1. Fans shall run continuously but can be started and stopped through the BAS.
 2. Provide an airflow switch at the fan inlet to monitor fan operation. Upon failure of the fan, an audio/visual alarm in the space shall be energized and an alarm shall be sent to the Operator Workstation.
- N. Fan Coil Units
1. Provide a DDC controller, a space temperature sensor, a heating coil valve and a cooling coil valve as scheduled. Modulate either heating coil valve or cooling coil valve to maintain setpoint. Fans shall run continuously.
 2. Fan shall run continuously in the occupied mode and be energized only in the unoccupied mode when heating or cooling is required to maintain the unoccupied space temperature setpoint.
 3. Temperature Setpoints:
Unless otherwise noted - 75 deg F cooling and 70 deg F heating.
Electrical Rooms - 80 deg F cooling and 65 deg F heating.
Setpoints shall be adjustable.
 4. Safety Controls:
 - a. Provide a current switch that shall monitor fan status and indicate an alarm for fan failure at the Operator Workstation.
 - b. Whenever space temperature is 5° F (adjustable) above or below the setpoint, alarm the DDC System
 - c. Provide a water level sensor and locate in the cooling coil drain pan. If the water level rises above setpoint, de-energize the fan and indicate an alarm at the Operator Workstation.
 - d. Monitor differential pressure across the filter bank and indicate an alarm at the Operator Workstation for filter change.
- O. Booster Humidifier: Space humidity sensor shall modulate humidifier control valve to maintain 20% R.H. setpoint (adjustable). High limit sensor shall override control to limit duct humidity to 85% R.H. High limit control shall be fully modulating and have equal authority. High limit control loop shall have very fast response to sudden air temp changes. Locate high limit transmitter 10 feet downstream of dispersion tubes. Provide interlock with air handling units to close the control valve when AHU shuts down.
- P. Sump Water Level Monitoring: Provide ultrasonic type water level sensor at the sump and sewage ejector pits with analog signal. Provide "HIGH" and "CRITICAL" level alarms at the BAS Workstation based on water level.
- Q. Mechanical Room Wet Floor Sensor
1. Alarm the DDC system when a wet floor condition occurs
- R. Hot Water or Electric Propeller Unit Heater

1. A space sensor shall, through a DDC controller, energize the heater and fan on a drop in space temperature.
 2. Provide O.A. lockout of heater when O.A. temperature is above 60° (adj.).
 3. Monitor heater current switch for failure.
- S. Hot Water or Electric Cabinet Unit Heater
1. A space sensor shall, through a DDC controller, energize the heater and fan on a drop in space temperature.
 2. Provide O.A. lockout of heater when O.A. temperature is above 60° (adj.).
 3. Monitor heater current switch for failure.
- T. Water Leak Detection for Drain Pans
1. Provide rope type leak detection cables and transmitter located in pans as shown on the plumbing drawings.
 2. Provide hold down clips, transmitter and other accessories as recommended by the manufacturer.
 3. Locate transmitter at nearest DDC controller. Map leak detection back to the BAS with alarm and location designation at the BAS.
- U. Split System Air Conditioning Units
1. Mini-split / fan-coil air conditioners are self-contained units with indoor and outdoor units. Controls are packaged internal to the unit.
 2. Provide inter-connecting control wiring between indoor and outdoor unit.
 3. Provide wall mounting bracket to mount thermostat.
 4. Provide a room temperature sensor connected to a DDC controller and mapped back to the BAS. Provide an alarm at the BAS if room temperature is above 85° or below 60°.
- V. Meds. Refrigerator Alarm Monitoring
1. Interface with the meds refrigerator temperature alarm system. This is a self-contained monitor with output contacts.
 2. Provide connection to this system, map alarm back to the BAS system and arrange to alarm at the BAS on contact closure.
- W. Room Pressure Monitors
1. Provide TSI room pressure monitors where shown on plan
 2. Isolation Rooms Only: Provide a key switch to deactivate the sensor to allow the room to be used as non-isolation with the door open.
 3. Provide Operator Workstation monitoring of alarms and room pressure through an electronic interface with the monitor.
 4. Provide programming of the sensor with 45 second delay for door opening. Alarm setpoint shall be -.01" or less.
- X. Trend & Isolation Room Trend Logs
1. Division 23 contractor shall set-up trend logs of actual room pressure, room temperature and room humidity to allow Geisinger to maintain records for state and federal authorities.
 2. Trend logs shall be set up to re-card hourly and arranged to print at the maintenance shop work station every 24 hours or as directed by Geisinger.
 3. Rooms to be trend logged include:
 - a. Procedure Rooms
 - b. Operating Rooms
 - c. Isolation Rooms

Y. Air Curtain (HAC) Control:

1. Unit shall be controlled by self-contained controller with field installed door switch.
2. When enabled the fans shall run on high speed through contacts in the automatic door controller. A time delay relay shall delay fan shutdown.
3. When enabled the fans shall run on high speed through contacts in the automatic door controller. A time delay relay shall delay fan shutdown.
4. Provide current switch monitoring of fan failure.
5. Provide interface with door control panels to enable or disable air curtain operation based on door operation with time delay.
6. Provide O.A. lockout of heater when O.A. temperature is above 60° (adj.).
7. Monitor heater current switch for failure.

Z. Emergency Generator

1. The emergency generator shall communicate to the BAS through a MODBUS communications card. Coordinate mapping of points with owner.
2. Provide hard wired status and alarm indication from generator control panel.

AA. Power Failure Shutdown/Restart Sequence

1. Each automatic transfer switch shall be monitored for normal operation, emergency operation, and test/manual mode.
2. Upon a changeover to emergency power as indicated by a signal from any of the Automatic Transfer Switches connected to the emergency power system, the BAS shall de-energize all HVAC equipment on emergency power. After ATS-EQT1 through EQT#, ATS-CH1 through CH4, and ATS-CH# have switched to emergency power, the BAS shall sequentially restart all HVAC equipment connected to emergency power.
3. The motor loads shall be energized in the following order:
 - a. Chilled water, condenser water, and hot water pumps
 - b. Third Floor Mechanical Air Handling Equipment
 - c. Remaining Tower CUP Equipment
 - d. The motors having the highest inrush current energized next. A reprogrammable time delay shall be provided between all motor load starts.
4. After all ATS's have switched to emergency power, the BAS shall shutdown all HVAC equipment connected to the normal power system.
5. Power Failure Restart Sequence: Upon resumption of normal power, the loads on emergency power shall seamlessly transfer and non-emergency motor loads that are scheduled to run shall be sequentially energized. A reprogrammable time delay shall be provided between all motor load starts.

BB. Carbon Monoxide Alarm: Provide wiring from carbon monoxide alarm panel(s) in boiler and generator rooms (see fire alarm drawings for locations) to alarm system for alarm.

CC. Chiller Room Alarm: Provide wiring from chiller room refrigerant monitoring panel to alarm system for alarm.

DD. Stairwell Pressurization System

1. System shall be energized by Division 28. Upon activation of system, Division 28 will send a signal to the BAS that stair pressurization mode is activated, open the fan inlet damper and energize the stair pressurization fan.
2. BAS contractor shall provide two (2) current sensors; one for status indication at the Operator Workstation and one for use by Division 28.

3. BAS contractor shall furnish and install intake air damper with 120 VAC operator (also provide power). Division 28 will provide and wire control device (CM) to operate.
4. BAS contractor shall provide two damper end switches. One end switch shall be wired into the fan safety circuit and one shall be for use by Division 28.
5. BAS contractor shall provide a voltage sensor to monitor the incoming voltage to the fan starter for use by Division 28.
6. Upon activation of the stair pressurization system, BAS shall open stair relief air isolation damper.
7. BAS contractor shall provide a room pressure monitor at the top and bottom of Stairs 1 and 2 to monitor differential pressure at those locations and to control VFD on fan motor to maintain stair pressure at set point of +0.20" w.c. and not to exceed high limit set point of +0.35" w.c. when the system is active.
8. Provide a modulating damper at each injection point. Initial damper positions shall be based on field balancing of the system to maintain design flow rate at each injection point.
9. Variable speed drive shall be monitored through a BACnet communication interface and through the fault relay on the drive.

EE. Fire Command Center Interface

1. All Tower air-handling systems (AHU-1-1 through 1-6, 4-1 through 4-12, 5-1, and 10-1 through 10-4) shall interface to the fire alarm control panel located in the Fire Command Center. BAS shall indicate "System Running" status to the fire alarm system. Fire alarm system shall be capable of remotely starting and stopping each unit via the fire alarm control panel. Operation of units from the Fire Command Center shall override BAS modes of operation (occupied, unoccupied, natural ventilation) but should not override system safeties.

FF. Comprehensive Building Energy Metering

1. General: Provide a BAS BACnet MS/TP interface to flow meter monitoring panels. Coordinate with Division 23 Contractor for chilled water and hot water monitoring. Provide a Modbus interface to the Power Metering system and coordinate with Division 26 Contractor for power monitoring.
2. Chilled Water Meter Monitoring
 - a. General: BTU Meter panel shall be furnished by BAS Contractor. Provide all wiring required and DDC Panels required to connect to the BACnet MS/TP network connections of the panel to monitor the following interface points at the BAS Operator Workstation:
 1. Total Energy (BTU)
 2. Energy Rate (BTU/HR)
 3. Flow Rate (GALLONS/MINUTE)
 4. Supply Temperature (°F)
 5. Return Temperature (°F)
3. Heating Hot Water Meter Monitoring
 - a. General: BTU Meter panel shall be furnished by BAS Contractor. Provide all wiring required and DDC Panels required to connect to the BACnet MS/TP network connections of the panel to monitor the following interface points at the BAS Operator Workstation:
 1. Total Energy (BTU)
 2. Energy Rate (BTU/HR)
 3. Flow Rate (GALLONS/MINUTE)
 4. Supply Temperature (°F)

5. Return Temperature (°F)
4. Domestic Hot Water Meter Monitoring
 - a. General: BTU Meter panel shall be furnished by BAS Contractor. Provide all wiring required and DDC Panels required to connect to the BACnet MS/TP network connections of the panel to monitor the following interface points at the BAS Operator Workstation:
 1. Total Energy (BTU)
 2. Energy Rate (BTU/HR)
 3. Flow Rate (GALLONS/MINUTE)
 4. Leaving Water Temperature (°F)
 5. Entering Water Temperature (°F)
5. Domestic Water, Make-Up Water and Blow Down Water Monitoring
 - a. General: Pulse type meter shall be furnished by BAS Contractor. Provide all wiring required and DDC Panels required to connect to the BAS network to monitor the following points at the BAS Operator Workstation:
 1. Totalized Flow (GALLONS)
6. Provide energy meters on chilled water, heating water and domestic hot water systems as follows:
 - a. The following systems/services will require BTU metering:
 1. Chilled water main service
 2. Chilled beam main service
 3. Heating water main service
 4. Domestic hot water main
7. Electrical Energy Monitoring
 - a. Measurement devices are provided by Division 26 for the purpose of monitoring electrical energy use for each of the following (separately).
 1. Total Electrical Energy
 2. HVAC Systems
 3. Interior Lighting
 4. Exterior Lighting
 5. Receptacle Circuits
 - b. Electrical energy use shall be recorded by the BAS every 15 minutes for criteria specified above. Reporting shall be available for the Owner's use hourly, daily, monthly, and annually. Collected data shall be stored for 36 months.
8. Natural Gas Monitoring
 - a. Measurement devices are provided by Division 22 for the purpose of monitoring natural gas building use.
 - b. The natural gas use for the new patient tower shall be recorded every 60 minutes. Reports shall be made available for the Owner's use hourly, daily, monthly, and annually. Collected data shall be stored for 36 months.

3.2 GRAPHICS AND ALARMS

- A. Graphics shall be provided for all points indicated and are required to access operational and alarm set points. Trending shall be configured and accessible for all analog and digital points to facilitate troubleshooting. All graphics shall show both set point value and current value on the same graphic.

- B. All alarms shall be configured for the capability to generate alarm notifications to Virtua facility maintenance personnel cell phones and/or email.
- C. Points indicated on drawings represent the minimum points required. Provide additional points as required to perform specified sequences.

END OF SECTION 230933

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Chilled Water Piping
 - 3. Condenser Water Piping
 - 4. Condensate Drain Piping
 - 5. Makeup-water piping.
 - 6. Blowdown-drain piping.
 - 7. Air-vent piping.
 - 8. Safety-valve-inlet and -outlet piping.

1.3 DEFINITIONS

- A. PTFE: Polytetrafluoroethylene.

1.4 PERFORMANCE REQUIREMENTS

- A. Design working pressure and temperature for all specialties and accessories suitable for system operating temperature and pressure indicated on the drawings and 125 psig at 225° F minimum except as noted below.
 - 1. Chilled Water Piping: See flow diagrams for pressure requirements.
 - 2. Condenser Water Piping: 175 psig at 200 deg F.
 - 3. Hot-Water Heating Piping: See flow diagrams for pressure requirements.
 - 4. Makeup-Water Piping: 100 psig at 150 deg F.
 - 5. Condensate Drain: 150 deg F.
 - 6. Blowdown Drain Piping: 200 deg F
 - 7. Air-Vent Piping: 200 deg F.
 - 8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pressure-seal fittings.
 - 2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 3. Air control devices.
 - 4. Hydronic specialties.
 - B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - C. Welding certificates.
 - D. Qualification Data: For Installer.
 - E. Field quality-control test reports.
 - F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
- 1.6 QUALITY ASSURANCE
- A. Installer Qualifications: Installers of Pressure Sealed Joints: Installers shall be certified by the pressure seal joint manufacturer as having been trained and qualified to join piping with pressure seal pipe couplings and fittings.
 - B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
 - D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.
 - E. Grooving tools shall be supplied by the mechanical grooved coupling manufacturer and shall form grooves that conform to ANSI/[AWWA](#) C-606 standards.
 - F. All mechanical grooved piping work including pipe grooving, shall be accomplished in accordance to the latest published grooved mechanical coupling manufacturer's installation instructions.

1.7 EXTRA MATERIALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flow meter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. S. P. Fittings; a division of Star Pipe Products.
 - c. Victaulic Company of America.
 - d. or Equal
 - 2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
 - 3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- E. Copper or Bronze Pressure-Seal Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Stadler-Viega.
 - b. Elkhart
 - c. Pro-Press
 - d. or Equal
 - 2. Housing: Copper.
 - 3. O-Rings and Pipe Stops: EPDM.
 - 4. Tools: Manufacturer's special tools.
 - 5. Minimum 200-psig working-pressure rating at 250 deg F
- F. Copper, Mechanically Formed Tee: For forming T-branch on copper water tube:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following

- a. T-DRILL, Industries Inc.
- b. or Equal

B. Press Joint Fittings and Couplings:

- 1. Acceptable Manufacturers:
 - a. Viega "Pro-Press"
- 2. Quality Assurance: All components of the Press Joint System, pipe ends, joints, fittings, valves and valve ends, and joining tools shall be completely compatible. The Press system manufacturer shall certify in writing the compatibility of the joints, valves and tools.
- 3. Fittings: Wrought copper press fittings shall be made from commercially pure copper mill products per ASTM B75 Alloy C12200. Cast copper alloy press fittings shall be made from materials with a minimum of 78% copper and a maximum of 15% zinc. The press fittings connections shall be compatible with seamless Type L copper tube made to ASTM B88. Fittings shall have a maximum non-shock working pressure of minimum 200 PSI between the temperatures of -20°F and +250°F. Elastomeric seals shall be made of EPDM material, and the fittings shall be manufactured with an inboard bead design. All fittings shall be installed in accordance with the manufacturer's installation instructions and according to local plumbing and mechanical codes. The press-to-connect joint shall be made with pressing tools and jaw sets recommended and authorized by the manufacturer.
- 4. Valves: Valves shall be as specified elsewhere in this Section, with male or female press to connect ends rated at minimum 200 psi CWP to 250°F maximum. Valves shall be compatible with Press system fittings and tooling.
- 5. Maximum acceptable pipe size shall not exceed 2 1/2 inches.

G. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
 - c. National Fittings, Inc.
 - d. S. P. Fittings; a division of Star Pipe Products.
 - e. Victaulic Company of America.
 - f. or Equal
 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- I. Steel Pipe Nipples: ASTM A 733 made of same materials and wall thicknesses as pipe in which they are installed.
- J. Steel Weld Outlet Fittings: 90 degree branching from main runs of pipe may utilize weld-o-let fittings in accordance with ANSI/ASME B16.9, ANSI/ASME B16.25. Pipe sizes 8" and larger shall use heavy wall weld-o-lets.
- K. Copper Compression Fittings: ASTM B88, Seamless Copper Water Tube, as indicated in "Section 4: Compression fittings on copper and stainless steel tubing" Guide
- L. Mechanically Formed, Copper-Tube-Outlet Joints: 90 degree branching from main runs of pipe may utilize mechanically formed copper-tube-outlet joints in accordance with manufacturer recommended procedures.
- 2.3 DIELECTRIC FITTINGS
- A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - d. or Equal
2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - e. or Equal
2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 - c. or Equal
2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Perfection Corporation; a subsidiary of American Meter Company.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Victaulic Company of America.
 - e. or Equal
2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Building Control System."
- C. Bronze, Calibrated-Orifice, Balancing Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Taco.
 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Taco.
 - g. Tour & Andersson; available through Victaulic Company of America.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - d. Conbraco Industries, Inc.
 - e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.

5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - d. Conbraco Industries, Inc.
 - e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flow Design Inc.
 - b. Griswold Controls.
 - c. ITT Bell and Gossett
 - d. Nexus
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 300 psig.

- 9. Maximum Operating Temperature: 250 deg F.
- H. Calibrated Balancing Valves and Automatic Flow-Control Valves shall not be required on devices where pressure independent control valves are installed, in accordance with Section 230900.

2.5 AIR CONTROL DEVICES

- A. Acceptable Manufacturers:
 - 1. Amtrol, Inc.
 - 2. Armstrong Pumps, Inc.
 - 3. Bell & Gossett Domestic Pump; a division of ITT Industries
 - 4. Taco.
- B. Design working pressure and temperature for all specialties and accessories, suitable for system operating pressure and temperature, 125 psig at 225° F minimum.
- C. Manual Air Vents
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Screwdriver or thumbscrew.
 - 4. Inlet Connection: NPS 1/2.
 - 5. Discharge Connection: NPS 1/8.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.
 - 8. Provide 1/4 inch vent cock.
- D. Automatic Air Vents
 - 1. Body: Bronze or cast iron.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Noncorrosive metal float.
 - 4. Inlet Connection: NPS 1/2.
 - 5. Discharge Connection: NPS 1/4.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 240 deg F.
- E. Air Separator
 - 1. Centrifugal type similar to Bell & Gossett "Rolairtrol" Type R, with steel tank, perforated stainless steel air collector and drain connection, ASME stamped for 125 psi working pressure and 300 deg F maximum operating temperature unless noted otherwise on schedule.
 - 2. Size in accordance with manufacturer's recommendations for circulating rate of system, but not less than adjacent pipe size or greater than 5 ft pressure drop at design flow rate; provide larger size separator as required.
- F. Air Purgers:

1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Maximum Working Pressure: 150 psig.
3. Maximum Operating Temperature: 250 deg F.

2.6 EXPANSION TANK

1. Precharged and pressurized expansion tank, welded carbon steel ASME constructed and stamped for maximum working pressure or minimum 225 psi, with sealed-in elastomer diaphragm suitable for temperatures to 240° F. Provide air charging fitting, pressure gauge and drain fitting. Provide vertical unit with base for floor mounting.
2. Bladder or Diaphragm type as scheduled. Welded steel construction.
3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings suitable for maximum operating temperature and pressure.
4. Tank Drain Fitting: Brass body, nonferrous internal parts; suitable for maximum operating temperature and pressure, constructed to admit air to compression tank, drain water, and close off system.
5. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch diameter gage glass, and slotted-metal glass guard.
6. Air Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
 2. End Connections: Grooved ends.
 3. Strainer Screen: 40 mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 4. CWP Rating: 750 psig.
- D. Stainless-Steel Bellow, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 2. End Connections: Threaded or flanged to match equipment connected.
 3. Performance: Capable of 3/4-inch misalignment.
 4. CWP Rating: 150 psig.
 5. Maximum Operating Temperature: 250 deg F.
- E. Spherical, Rubber, Flexible Connectors:
1. Body: Fiber-reinforced rubber body.
 2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
 3. Performance: Capable of misalignment.
 4. CWP Rating: 150 psig.
 5. Maximum Operating Temperature: 250 deg F.
- F. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping".

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure-seal joints; mechanically formed tee fittings, or compression fittings.
 2. ASTM A53 Schedule 40, black steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
1. ASTM A53 Schedule 40, black steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges, mechanical grooved couplings, and flange fittings, and welded, flanged, or mechanically grooved coupling joints.
 2. Within accessible spaces, in lieu of flanged equipment connections: Schedule 40, black steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints, up to NPS 24.

- C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints. Nipples Schedule 80.
- D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Type L, drawn-temper copper tubing, wrought-copper fittings up to NPS 3 (DN 80).
 - 3. Within accessible spaces, in lieu of flanged equipment connections: Schedule 40, black steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints, up to NPS 24
 - 4. Schedule 40 steel pipe, except 0.375 inch wall for sizes 12 inches and larger. Wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Nipples Schedule 80.
- E. Condenser-water piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints. Nipples Schedule 80.
- F. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Within mechanical equipment rooms, in lieu of flanged equipment connections: Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
 - 3. Schedule 40 steel pipe, except 0.375 inch wall for sizes 12 inches and larger. Wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints. Nipples Schedule 80.
 - 4. Polypropylene
- G. Makeup-water piping installed aboveground shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, soldered or mechanical pressure sealed joints.
- H. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, soldered or mechanical pressure sealed joints.
 - 2. Pressure seal type fittings (Viega Propress or similar) are acceptable for condensate drain piping up to 2" in diameter.
 - 3. Rubber tubing is not acceptable for condensate drain lines.

- I. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- J. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
- K. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

3.2 VALVE APPLICATIONS

- 1. General Install shutoff duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B.
 - 1. Install shutoff duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
 - 2.
 - 3. Install check valves at each pump discharge and elsewhere as required to control flow direction.
 - 4. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
 - 5. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.
 - 6. Examine threads on valve and mating pipe for form and cleanliness.
 - 7. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.
 - 8. Do not attempt to repair defective valves; replace with new valves.
 - 9. Install valves in horizontal piping with stem at or above the center of the pipe.
 - 10. Install valves in a position to allow full stem movement.
- C. Check Valves: Provide lift check type after globe valves, install with stem upright and plumb. Provide nonslam type in vertical piping on discharge side of pumps and elsewhere as indicated or specified. Provide horizontal swing check type elsewhere unless otherwise indicated or required for service intended, install in horizontal position with hinge pin level. Install check valves, including those that are spring loaded, so that force of gravity will operate to close valves.

- D. Provide valve ends to suit character of pipe in which installed. Provide valves designed for working pressure of at least 125% of maximum operating pressure of system in which installed, but not less than 250 psig on high pressure systems, and 125 psig on low pressure systems.
- E. Plug Valves: Provide 1/4 inch needle valve with nipple and cap at each gauge tap where there is no flow measuring device to measure flow. Otherwise, plug each tap.
- F. Equip shutoff valve, each main and each major branch valve 4 inches and larger in size in Boiler and Mechanical Room and Penthouse Central Utilities Building installed in a line over 7 feet above floor and other valves indicated as chain operated with appropriate size babbitt adjustable sprocket rim, chain and chain guide. Continuous chain shall reach within six feet of floor. Use only valves available with chain operators. Install with wheel in vertical plane
- A. Install calibrated-orifice, balancing valves at each branch connection to return main that serves more than 5 coil connections. Provide throttling duty shut-off valves at all connection serving less than 5 coil connections. No additional shut-off valve is required for lines with a single coil connection.
- B. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.
- C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Pressure requirements noted indicate general requirements for multiple hydronic systems. Refer to flow diagrams for pressure requirements for Chilled Water and Heating Hot Water piping.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.

- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- M. Install drains, consisting of a tee fitting or mechanically formed tee, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage. Do not install drains and vents at localized vertical offsets, less than 3 feet.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified herein. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.

2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/2: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 4. NPS 2: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 6. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 7. NPS 4: Maximum span, 12 feet; minimum rod size, 5/8 inch.
 8. NPS 6: Maximum span, 12 feet; minimum rod size, 3/4 inch.
 9. NPS 8: Maximum span, 12 feet; minimum rod size, 3/4 inch.
 10. NPS 10: Maximum span. 12 feet; minimum rod size 7/8 inch.
 11. NPS 12: Maximum span. 12 feet; minimum rod size 7/8 inch.
 12. NPS 14 and over: Maximum span. 12 feet; minimum rod size 1 inch.
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2-1/2: Maximum span, 8 feet; minimum rod size, 1/2 inch.
 6. NPS 3: Maximum span, 8 feet; minimum rod size, 1/2 inch.
- E. Provide additional supports as required to avoid overloading of supporting structure. Reduce distance where so required by applicable codes.
- F. Trapeze hanger rods shall be sized to carry the weight of the trapeze hanger channel, span of piping with contents, insulation and supports, plus a 200 lb live load.

- G. Install hangers to provide minimum ½ inch clear space between finished covering and adjacent work.
- H. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints/loops.
- I. Place a hanger within one foot of each horizontal elbow.
- J. Use hangers that are vertically adjustable 1-1/2: minimum after piping is erected.
- K. Vertical Piping Support
 - 1. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
 - 2. For exposed piping in stairs and finished areas, locate clamps below floor and secure to structure below floor as required.
- L. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between piping anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units, and so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.

3.5 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
- J. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end- pipe couplings. Grooved joints shall be limited to use within mechanical equipment rooms for connections to chillers, boilers, mechanical equipment, pumps, valves, strainers or other devices located within the mechanical equipment room.
- K. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- L. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- I. Air Vents
 - 1. Provide as indicated or required to fully vent air from the system.
 - 2. Provide manual type air vents for radiation and for fan coil units, unit heaters, small water coils and similar equipment.
 - 3. Provide float type, automatic air vents with valved inlet and discharge piped to floor drain for large capacity water coils, as in air handling units, for large piping mains and other major equipment in equipment rooms, and where indicated on Drawings.
 - 4. Provide manual type air vents at high points of water circulating systems with pipe size air chamber, minimum 2 inches. Where high points are not readily accessible, provide 1/4 inch piping and tubing to manual air vent and locate valve in an accessible location.
 - 5. Provide high capacity float type vent, piped to drain, on boiler air vent connection.
- J. Expansion Tank
 - 1. Provide expansion tank for the following systems:
 - a. Chilled Water
 - b. Heating Water
 - c. Heat Recovery
- K. Pressure/Temperature Test Plugs: Provide nipple as required to locate cap of P/T plug outside of surface of pipe insulation.
- L. Relief Valves

1. Provide as required or shown on all water systems and equipment. Aggregate relieving capacity as required by ASME Code. Install valve(s) furnished by boiler manufacturer if not factory installed.
2. Select system relief valve capacity so that it is greater than makeup pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
3. Pipe relief valve outlet to nearest floor drain.
4. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

A.

B. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

C. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test. Joints that are shop tested may be insulated prior to shipping.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test.
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes special-duty valves and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Makeup-water piping.
 - 3. Condensate-drain piping.
 - 4. Air-vent piping.
 - 5. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air-control devices.
 - 3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated: (For Package 3 piping refer to general notes and flow diagrams for piping minimum system pressure ratings.)

A.

1. Hot-Water Heating Piping: 150 psig at 200 deg F (93 deg C).
2. Makeup-Water Piping: 100 psig at 150 deg F (66 deg C)
3. Condensate-Drain Piping: 150 deg F (66 deg C)
4. Air-Vent Piping: 200 deg F (93 deg C)
5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping." Section 15112 "General-Duty Valves for HVAC Piping."

- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."

- C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Nexus Valve, Inc.
 - g. Taco.
 - h. Tour & Andersson; available through Victaulic Company.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett Domestic Pump.
 - c. Flow Design Inc.
 - d. Gerand Engineering Co.
 - e. Griswold Controls.
 - f. Nexus Valve, Inc.
 - g. Taco.
 - h. Tour & Andersson.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig (860 kPa).
11. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump.
 - d. Conbraco Industries, Inc.
 - e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump.
 - d. Conbraco Industries, Inc.
 - e. Spence Engineering Company, Inc.
 - f. Watts Regulator Co.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Flow Design Inc.
 - b. Griswold Controls.
 - c. Nexus Valve, Inc.
2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig (1207 kPa)
9. Maximum Operating Temperature: 200 deg F (93 deg C)

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump.
 - d. Nexus Valve, Inc.
 - e. Taco, Inc.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2 (DN 15).
6. Discharge Connection: NPS 1/8 (DN 6).
7. CWP Rating: 150 psig (1035 kPa).
8. Maximum Operating Temperature: 225 deg F (107 deg C).

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett Domestic Pump.
 - d. Nexus Valve, Inc.
 - e. Taco, Inc.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2 (DN 15).
6. Discharge Connection: NPS 1/4 (DN 8).
7. CWP Rating: 150 psig (1035 kPa).
8. Maximum Operating Temperature: 240 deg F (116 deg C).

2.4 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig (860 kPa).

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

D. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

F. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping."Section 15124 "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
- E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- F. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Install tank fittings that are shipped loose.
 - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- G. Install expansion tanks on the floor. Vent and purge air from hydronic system and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Separately coupled, horizontal, in-line centrifugal pumps.
 - 2. Separately coupled, base-mounted, end-suction centrifugal pumps.
 - 3. Separately coupled, base-mounted, double-suction centrifugal pumps.
 - 4. Automatic condensate pump units.

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection.

2.2 SEPARATELY COUPLED, HORIZONTAL, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Grundfos Pumps Corporation.
 - 4. Taco, Inc.

- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F unless otherwise noted on pump equipment schedule.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
 - 5. Pump Bearings: Permanently lubricated ball bearings.
- D. Shaft Coupling: Molded rubber insert with interlocking spider capable of absorbing vibration.
- E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.3 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Taco, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for minimum 225-psig minimum working pressure and a continuous water temperature of 225 deg F unless otherwise noted on pump equipment schedule.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.
 - 5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor, EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

- A. Manufacturers:
 - 1. Armstrong Pumps Inc.
 - 2. Bell & Gossett; Div. of ITT Industries.
 - 3. Taco, Inc.
- B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for minimum 225-psig minimum working pressure and a continuous water temperature of 225 deg F unless otherwise noted on pump equipment schedule.
- C. Pump Construction:
 - 1. Casing: Horizontally split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 250 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket.
 - 5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor, EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 AUTOMATIC CONDENSATE PUMP UNITS

- A. Manufacturers:
 - 1. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.
- B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.
- C.

2.6 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 225-psig pressure rating, ductile iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
- 1. Manufacturers:
 - a. Bell and Gossett
 - b. Armstrong

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Common Work Results for HVAC."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 PUMP INSTALLATION

- A. Comply with ANSI/HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- E. Suspend horizontally mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 21 Section "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment." Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment/Hangers and Supports for HVAC Piping and Equipment."
- F. Provide laser alignment for all pumps.
- G. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
 - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
 - 2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
- H. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.4 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made. Alignment of pump and motor shaft shall be completed by a factory authorized representative using the reverse dial indicator or laser alignment method to within a maximum deviation of 0.02 mil/inch of dial indicator separation at each dial indicator.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. Adjust pump and motor shafts for angular and offset alignment by methods specified in ANSI/HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation; ANSI/HI 2.1-2.5, " Vertical Pumps for Nomenclature, Definitions, Application and Operation."
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Provide individual check, balancing, and isolation valves. Installation of triple-duty valve on discharge side of pumps shall not be acceptable.
- F. Install Y-type strainer or suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- I. Install check valve and gate or ball valve on each condensate pump unit discharge.
- J. Install electrical connections for power, controls, and devices.
- K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 232123

SECTION 232213 - STEAM AND CONDENSATE HEAT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following for steam and condensate piping:

1. Pipe and fittings.
2. Strainers.
3. Flash tanks.
4. Safety valves.
5. Pressure-reducing valves.
6. Steam traps.
7. Thermostatic air vents and vacuum breakers.
8. Steam and condensate meters.

1.3 DEFINITIONS

- A. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.
- B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
 1. HP Steam Piping: 50-100 psig
 2. LP Steam Piping: 0-50 psig
 3. Condensate Piping: at 250 deg F
 4. Makeup-Water Piping: 80 psig at 150 deg F.
 5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
 6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
 7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 1. Pressure-reducing and safety valve.
 2. Steam trap.
 3. Air vent and vacuum breaker.
 4. Flash tank.

5. Meter.

- B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.
- C. Welding certificates.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."
- B. Pipe Welding: Qualify processes and operators according to the following:
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. Wrought-Copper Fittings and Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.
- C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.
- E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.
- I. Stainless-Steel Bellows, Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
 - 2. End Connections: Threaded or flanged to match equipment connected.
 - 3. Performance: Capable of 3/4-inch misalignment.
 - 4. CWP Rating: 150-psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.4 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hart Industries, International Inc.
 - b. Watts Water Technologies, Inc.
 - c. Zurn Plumbing Products Group.
 - 2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Water Technologies, Inc.
 - 2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Pipeline Seal and Insulator, Inc.
 - 2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure as required to suit system pressures.

2.5 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Stop-Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.
 - b. Jenkins Valves; a Crane Company.
 - c. Lunkenheimer Valves.
 - 2. Body and Bonnet: Malleable iron.
 - 3. End Connections: Flanged.
 - 4. Disc: Cylindrical with removable liner and machined seat.
 - 5. Stem: Brass alloy.
 - 6. Operator: Outside screw and yoke with cast-iron handwheel.
 - 7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
 - 8. Pressure Class: 250.

2.6 STRAINERS

- A. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 - 3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. Tapped blowoff plug.
 - 5. CWP Rating: 250-psig working steam pressure.

2.7 FLASH TANKS

- A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.8 SAFETY VALVES

- A. Bronze or Brass Safety Valves:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong International, Inc.
 - b. Kunkle Valve; a Tyco International Ltd. Company.
 - c. Spirax Sarco, Inc.

- d. Watts Water Technologies, Inc.
 - 2. Disc Material: Forged copper alloy.
 - 3. End Connections: Threaded inlet and outlet.
 - 4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 - 5. Pressure Class: 250.
 - 6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
 - 7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
- B. Cast-Iron Safety Valves:
- 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong International, Inc.
 - b. Kunkle Valve; a Tyco International Ltd. Company.
 - c. Spirax Sarco, Inc.
 - d. Watts Water Technologies, Inc.
 - 2. Disc Material: Forged copper alloy with bronze nozzle.
 - 3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
 - 4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 - 5. Pressure Class: 250.
 - 6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
 - 7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
 - 8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.9 PRESSURE-REDUCING VALVES

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 1. Armstrong International, Inc.
 - 2. Hoffman Specialty; Division of ITT Industries.
 - 3. Spence Engineering Company, Inc.
 - 4. Spirax Sarco, Inc.
- B. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
- C. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.
- D. Body: Cast iron.

- E. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
- F. Trim: Hardened stainless steel.
- G. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
- H. Gaskets: Non-asbestos materials.

2.10 STEAM TRAPS

A. Thermostatic Traps:

- 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty; Division of ITT Industries.
 - c. Spirax Sarco, Inc.
- 2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
- 3. Trap Type: Balanced-pressure.
- 4. Bellows: Stainless steel or monel.
- 5. Head and Seat: Replaceable, hardened stainless steel.
- 6. Pressure Class: 125.

B. Thermodynamic Traps:

- 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty; Division of ITT Industries.
 - c. Spirax Sarco, Inc.
- 2. Body: Stainless steel with screw-in cap.
- 3. End Connections: Threaded.
- 4. Disc and Seat: Stainless steel.
- 5. Maximum Operating Pressure: 600 psig.

C. Float and Thermostatic Traps:

- 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty; Division of ITT Industries.
 - c. Spirax Sarco, Inc.

2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

D. Inverted Bucket Traps:

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty; Division of ITT Industries.
 - c. Spirax Sarco, Inc.
2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.11 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty; Division of ITT Industries.
 - c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 300 psig
7. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong International, Inc.
 - b. Hoffman Specialty; Division of ITT Industries.
 - c. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-ring Seal: EPR.
6. Pressure Rating: 300 psig
7. Maximum Temperature Rating: 350 deg F.

2.12 STEAM METERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. EMCO Flow Systems; Division of Advanced Energy Company.
 2. ISTECH Corp.
 3. Preso Meters; a division of Racine Federated Inc.
 4. Spirax Sarco, Inc.
- B. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.
 1. Computer shall have 4 to 20-mA or 2 to 10 volt output for temperature, pressure, and contact closure for flow increments.
 2. Independent timers to store four peak flow rates and total flow.
 3. Interface compatible with central workstation described in Division 23 Section "Instrumentation and Control for HVAC."
 4. Microprocessor Enclosure: NEMA 250, Type 4.
- C. Sensor: Venturi, of stainless-steel construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
- D. Sensor: Vortex type with stainless-steel wetted parts and wafer connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.

2.13 CONDENSATE METERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Central Station Steam Co.
 2. Lincoln Meter Company.
- B. Body: Cast iron, bronze, or brass.

- C. Turbine: Copper, brass, or stainless steel.
- D. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.
- E. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.
 - 1. Computer shall have 4- to 20-mA or 2- to 10-volt output for temperature, pressure, and contact closure for flow increments.
 - 2. Independent timers to store four peak flow rates and total flow.
 - 3. Interface compatible with central workstation specified in Division 23 Section "Instrumentation and Control for HVAC."
 - 4. Microprocessor Enclosure: NEMA 250, Type 4.
- F. Pressure Rating: Atmospheric.
- G. Maximum Temperature Rating: 250 deg F.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

- A. LP Steam Piping, NPS 2 and Smaller: ASTM A53 Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
- B. LP Steam Piping, NPS 2-1/2 through NPS 12: ASTM A53 Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- C. Condensate piping above grade, NPS 2 and smaller, shall be either of the following:
 - 1. ASTM Schedule 80, Type S, Grade B, steel pipe; Class 150 cast-iron fittings; and threaded joints.
- D. Condensate piping above grade, NPS 2-1/2 and larger, shall be either of the following:
 - 1. ASTM Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 ANCILLARY PIPING APPLICATIONS

- A. Makeup-water piping installed above grade shall be the following:
 - 1. Drawn-temper copper tubing, wrought-copper fittings, and [soldered] [brazed] joints.
- B. Air-Vent Piping:
 - 1. Inlet: Same as service where installed.
 - 2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.
- C. Vacuum-Breaker Piping: Outlet, same as service where installed.

- D. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.3 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.4 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
- M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

- N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to top of main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.5 STEAM-TRAP INSTALLATION

- A. Install steam traps in accessible locations as close as possible to connected equipment.
- B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.6 PRESSURE-REDUCING VALVE INSTALLATION

- A. Install pressure-reducing valves in accessible location for maintenance and inspection.
- B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
- C. Install gate valves on both sides of pressure-reducing valves.
- D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.
- E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 23 Section "Meters and Gages for HVAC Piping."
- F. Install strainers upstream for pressure-reducing valve.
- G. Install safety valve downstream from pressure-reducing valve station.

3.7 STEAM OR CONDENSATE METER INSTALLATION

- A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's instructions.
- B. Provide data acquisition wiring. Refer to Division 23 Section "Instrumentation and Control for HVAC."

3.8 SAFETY VALVE INSTALLATION

- A. Install safety valves according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping."
- B. Pipe safety-valve discharge without valves to atmosphere outside the building.
- C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
- D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.9 HANGERS AND SUPPORTS

- A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing.
- B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
- D. Install hangers with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.
 - 6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
 - 7. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 - 8. NPS 6: Maximum span, 21 feet; minimum rod size, 1/2 inch.
 - 9. NPS 8: Maximum span, 24 feet; minimum rod size, 5/8 inch.
 - 10. NPS 10: Maximum span, 26 feet; minimum rod size, 3/4 inch.
 - 11. NPS 12: Maximum span, 30 feet; minimum rod size, 7/8 inch.
 - 12. NPS 14: Maximum span, 32 feet; minimum rod size, 1 inch.
 - 13. NPS 16: Maximum span, 35 feet; minimum rod size, 1 inch.
 - 14. NPS 18: Maximum span, 37 feet; minimum rod size, 1-1/4 inches.

15. NPS 20: Maximum span, 39 feet; minimum rod size, 1-1/4 inches.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 4 feet; minimum rod size, 1/4 inch.
2. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.10 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.11 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install traps and control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install vacuum breakers downstream from control valve, close to coil inlet connection.
- E. Install a drip leg at coil outlet.

3.12 FIELD QUALITY CONTROL

- A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- B. Perform the following tests on steam and condensate piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
 - 3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
- C. Prepare written report of testing.

END OF SECTION 232213

SECTION 232216 - STEAM AND CONDENSATE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following piping specialties for LP and HP steam and condensate piping:
 - 1. Strainers.
 - 2. Flash tanks.
 - 3. Safety valves.
 - 4. Pressure-reducing valves.
 - 5. Steam traps.
 - 6. Thermostatic air vents and vacuum breakers.
 - 7. Steam and condensate meters.
 - 8. Deaerator Tank.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pressure-reducing and safety valve.
 - 2. Steam trap.
 - 3. Air vent and vacuum breaker.
 - 4. Flash tank.
 - 5. Meter.
 - 6. Deaerator Tank.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to the following:
 - 1. ASME Compliance: Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 - 1. Condensate Piping: at 250 deg F.
 - 2. Makeup-Water Piping: 80 psig at 150 deg F.
 - 3. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
 - 4. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
 - 5. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."
- B. Stop-Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Cincinnati Valve Company.
 - c. Crane; Crane Energy Flow Solutions.
 - d. Jenkins Valves.
 - 2. Body and Bonnet: Malleable iron.
 - 3. End Connections: Flanged.
 - 4. Disc: Cylindrical with removable liner and machined seat.
 - 5. Stem: Brass alloy.
 - 6. Operator: Outside screw and yoke with cast-iron handwheel.
 - 7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
 - 8. Pressure Class: 250.

2.3 STRAINERS

- A. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 - 3. Strainer Screen: Stainless-steel, 20 mesh strainer, or perforated stainless-steel basket.
 - 4. Tapped blowoff plug.

5. CWP Rating: 250-psig working steam pressure.

B. Basket Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 250-psig working steam pressure.

2.4 FLASH TANKS

- A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.5 SAFETY VALVES

- A. Bronze or Brass Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Kunkle Valve.
 - c. Spirax Sarco, Inc.
 - d. Watts Regulator Co.
2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

- B. Cast-Iron Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Kunkle Valve.
 - c. Spirax Sarco, Inc.
 - d. Watts Regulator Co.

2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6 PRESSURE-REDUCING VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Armstrong International, Inc.
 2. Hoffman Specialty.
 3. Leslie Controls, Inc.
 4. Spence Engineering Company, Inc.
 5. Spirax Sarco, Inc.
- B. ASME labeled.
- C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
- D. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.
- E. Body: Cast iron.
- F. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
- G. Trim: Hardened stainless steel.
- H. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
- I. Gaskets: Non-asbestos materials.
- J. Capacities and Characteristics:
 1. Steam Flow Rate: See drawings/schedules
 2. Inlet Pressure: See drawings/schedules
 3. Outlet Set Pressure: See drawings/schedules
 4. Pressure Loss (Wide Open): See drawings/schedules

2.7 STEAM TRAPS

- A. Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Dunham-Bush, Inc.
 - d. Hoffman Specialty.
 - e. Spirax Sarco, Inc.
 - f. Sterling.
2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
3. Trap Type: Balanced-pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Pressure Class: 125.

B. Thermodynamic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Dunham-Bush, Inc.
 - d. Hoffman Specialty.
 - e. Spirax Sarco, Inc.
2. Body: Stainless steel with screw-in cap.
3. End Connections: Threaded.
4. Disc and Seat: Stainless steel.
5. Maximum Operating Pressure: 600 psig.

C. Float and Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Dunham-Bush, Inc.
 - d. Hoffman Specialty.
 - e. Spirax Sarco, Inc.
 - f. Sterling.
2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.

8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

D. Inverted Bucket Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Dunham-Bush, Inc.
 - d. Hoffman Specialty.
 - e. Spirax Sarco, Inc.
 - f. Sterling.
2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.8 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Dunham-Bush, Inc.
 - d. Hoffman Specialty.
 - e. Spirax Sarco, Inc.
 - f. Sterling.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 300 psig
7. Maximum Temperature Rating: 350 deg F

B. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Dunham-Bush, Inc.
 - c. Hoffman Specialty.
 - d. Johnson Corporation (The).
 - e. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-Ring Seal: EPR.
6. Pressure Rating: 300 psig
7. Maximum Temperature Rating: 350 deg F.

2.9 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Duraflex, Inc.
 - b. Flexicraft Industries.
 - c. Hyspan Precision Products, Inc.
 - d. Mason Industries, Inc.
 - e. Metraflex Company (The).
 - f. Twin City Hose, Inc.
2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

2.10 STEAM METERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. EMCO Flow Systems.
2. ISTECH Corp.
3. Preso Meters.
4. Spirax Sarco, Inc.

B. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.

1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.

2. Independent timers to store four peak flow rates and total flow.
 3. Interface compatible with central workstation described in Section 230900 "Instrumentation and Control for HVAC."
 4. Microprocessor Enclosure: NEMA 250, Type 4.
- C. Sensor: Venturi, of carbon-steel construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
- D. Sensor: Vortex type with stainless-steel wetted parts and wafer connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
- E. Sensor: Spring-loaded, variable-area flowmeter type; density compensated with stainless-steel wetted parts and wafer connections. At least 10:1 turndown with plus or minus 2 percent accuracy over full-flow range.

2.11 CONDENSATE METERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Central Station Steam Co.
 2. Lincoln Meter Company.
- B. Body: Cast iron, bronze, or brass.
- C. Turbine: Copper, brass, or stainless steel.
- D. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.
- E. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.
1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
 2. Independent timers to store four peak flow rates and total flow.
 3. Interface compatible with central workstation specified in Section 230900 "Instrumentation and Control for HVAC."
 4. Microprocessor Enclosure: NEMA 250, Type 4.
- F. Pressure Rating: Atmospheric.
- G. Maximum Temperature Rating: 250 deg F.

2.12 DEAERATOR

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. BFS Industries
- B. Deaerator shall be furnished on a skid complete with a horizontal, spray/scrubber type deaerator with integral deaerated water storage section with a minimum of 10 minutes of storage and 12"x16" manhole, structural steel unit frame for deaerator tank support, three (3) electric motor operated boiler feed pumps with high temp mechanical seals rated for 250°F, and system control center. All necessary piping, valves, fittings and wiring shall be provided to form a complete packaged system.
- C. The deaerator shall be supplied with the following accessories:
 - 1. Electric modulating water inlet control valve.
 - a. Model: BFS Accuflow with stainless steel body with 3 valve by-pass and strainer.
 - 2. 3" Self-contained, pilot actuated, diaphragm operated steam pressure reducing valve to reduce available steam pressure of 85 psig to the deaerator operating pressure of 5 psig.
 - a. Model Spence CL-250 ED.
 - 3. Overflow trap sized to pass the rated capacity of flashing water at operating pressure.
 - 4. Set safety type water glass gauges to cover the full water level travel.
 - 5. Water storage thermometer with separable socket.
 - 6. Steam pressure gauge.
 - 7. Water inlet pressure gauge.
 - 8. Vent valve.
 - 9. Set safety relief valves sized for the fail open capacity of the steam pressure reducing valve and set at the pressure vessel design pressure.
 - 10. High level alarm switch, M&M #64.
 - 11. Low level alarm switch (and pump cutoff), M&M #64.
 - 12. Vacuum Breaker.
 - 13. Differential pressure transmitter.
 - 14. Muffling orifice plate.
 - 15. Spare 3" connection w/ plug.
- D. The Deaerator shall be guaranteed to operate at all flow rates from 5% to 110% of outlet capacity and shall deaerate the water so that the oxygen in the effluent leaving the storage tank shall not exceed .005 cc/l as determined by the Heat Exchange Institute, Winkler Method or any modification as outlined by A.S.T.M. The Deaerator shall also be guaranteed to reduce the titratable free CO₂ to zero as determined by the A.P.H.A. method.
- E. The Deaerator pressure vessel shall be designed, constructed and stamped in accordance with the latest edition of the ASME code for 50 PSIG. Pressure vessel shall be constructed of a minimum of ¼" thick, SA-516-70 carbon steel material for shell and heads.
- F. The Deaerator shall be mounted on a structural steel support stand. The steel frame shall be constructed of wide flange beam. The stand shall elevate the bottom of the deaerator storage tank a minimum of 7' above the floor and allow for adequate NPSH for the boiler feed pumps

plus a suitable safety margin. Cross braces or gussets are required on the four sides of the stand to limit swaying of the structure.

- G. Boiler feed water pumps: Provide three (3) boiler feed water pumps; refer to schedule for capacity and performance. Pumps shall be low NPSH design. Pumps shall be complete with mechanical type seals rated for 250° F. Provide a variable frequency controller (VFC) per pump. Each VFC shall be shipped loose for installation by the contractor. Boiler feed water pump suction piping shall be provided by the deaerator manufacturer and installed by qualified personnel. The boiler feed pump suction piping shall be sized such that the maximum friction loss is 1.7' per 100' of pipe. The transfer pump suction piping will be sized with a maximum friction loss of 7' per 100' of pipe. The piping will consist of a gate valve, Y type strainer, expansion coupling and all interconnecting pipe and fittings. Piping will also include pump discharge pressure gauges w/ cocks (shipped loose) and a pump pressure transmitter (shipped loose). Minimum flow Recirculation piping will be factory piped with check valve, isolation valve and stainless steel recirculation orifice.
- H. Refer to schedule for capacity and performance.
- I. Control Panel
 - 1. UL approved and labeled as specified under the classification of "Industrial Control Panels".
 - 2. Model: Panel-Pac Model #JCA-120 consisting of the following:
 - a. NEMA #1 enclosure
 - b. 3 sets of VFD control with hand-off-automatic switch and running light
 - c. Low water pump cut-off relay
 - d. Auto-Direct BRX-36 PLC with 8" touch screen for alarm messaging, VFD control, lag pump selection and initiation, and scheduled rotation.
 - e. High/low level alarm system complete with high and low level indication lights, horn, and silencing/reset button.
- J. Warranty
 - 1. The packaged Deaerator system will be warranted for 1 Year from the date of startup or 18 Months from the date of shipment, against manufacturing defects. The manufacturer shall have been producing like equipment for a minimum period of 5 years.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 PIPING INSTALLATION

- A. Install piping to permit valve servicing.
- B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."
- D. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- E. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- H. Flash Tank:
 - 1. Pitch condensate piping down toward flash tank.
 - 2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
 - 3. Install thermostatic air vent at tank top.
 - 4. Install safety valve at tank top.
 - 5. Install full-port ball valve, and swing check valve on condensate outlet.
 - 6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
 - 7. Install pressure gage on low-pressure steam outlet according to Section 230519 "Meters and Gages for HVAC Piping."

3.3 STEAM-TRAP INSTALLATION

- A. Install steam traps in accessible locations as close as possible to connected equipment.
- B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.4 PRESSURE-REDUCING VALVE INSTALLATION

- A. Install pressure-reducing valves in accessible location for maintenance and inspection.
- B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
- C. Install gate valves on both sides of pressure-reducing valves.

- D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.
- E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Section 230519 "Meters and Gages for HVAC Piping."
- F. Install strainers upstream for pressure-reducing valve.
- G. Install safety valve downstream from pressure-reducing valve station.

3.5 STEAM OR CONDENSATE METER INSTALLATION

- A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.
- B. Provide data acquisition wiring. See Section 230900 "Instrumentation and Control for HVAC."

3.6 SAFETY VALVE INSTALLATION

- A. Install safety valves according to "Building ASME B31.1, "Power Piping"; and ASME B31.9, "Building Services Piping."
- B. Pipe safety-valve discharge without valves to atmosphere outside the building.
- C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
- D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Install traps and control valves in accessible locations close to connected equipment.
- B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

3.8 DEAERATOR INSTALLATION

- A. The unit shall be factory piped in accordance with the following:
 - 1. Vessel Piping:
 - a. All deaerator and surge tank accessories shall be factory piped except the steam pressure reducing valve and the overflow trap. All accessories piped on tank shall be provided with block valves to facilitate isolation should repair or removal be necessary. Block valves shall be Powell bronze or forged steel body
 - 2. Pump Suction Piping:

- a. Pump suction piping shall be provided by the deaerator manufacturer and installed by qualified personnel. The boiler feed pump suction piping shall be sized such that the maximum friction loss is 1.7' per 100' of pipe. The transfer pump suction piping will be sized with a maximum friction loss of 7' per 100' of pipe. The piping will consist of a gate valve, Y type strainer, expansion coupling and all interconnecting pipe and fittings. Piping will also include pump discharge pressure gauges w/ cocks (shipped loose) and a pump pressure transmitter (shipped loose).
 - 1) Pumps will serve all boilers via a common header provided by others
 - 2) Pump Discharge piping will be by others.
 - a) Up to 3": Powell Bronze body, threaded.
 - b) 4" and up: Powell Iron body, flanged, OS & Y, Rising stem
- 3. Pump Recirculation Piping:
 - a. Minimum flow Recirculation piping will be factory piped with check valve, isolation valve and stainless-steel recirculation orifice.

END OF SECTION 232216

SECTION 232223 – STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes electric-driven steam condensate pumps.

1.3 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.
- B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain steam condensate pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of steam condensate pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store steam condensate pumps in dry location.

- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 ELECTRIC-DRIVEN STEAM CONDENSATE PUMPS

- A. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pump(s), controls, and accessories suitable for operation with steam condensate.
- B. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 210 deg F steam condensate.
 - 1. Manufacturers:
 - a. Aurora Pump; Division of Pentair Pump Group.
 - b. Armstrong Pump.
 - c. Spence Engineering Company, Inc.; Division of Circor International, Inc.
 - d. Spirax Sarco, Inc.
 - e. Shipco
 - 2. Receiver: Floor-mounting, close-grained cast iron; externally adjustable float switches; with water-level gage, steam condensate thermometer, discharge-pressure gage for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.
 - 3. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
 - 4. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges with pump suction isolation valves; rated to operate with a minimum of 2 feet of NPSH.

5. Control Panel: NEMA 250, Type 1 enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
 - a. Motor controller for each pump.
 - b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
 - c. Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
 - d. Momentary contact "TEST" push button on cover for each pump.
 - e. Numbered terminal strip.
 - f. Disconnect switch.

2.3 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine rough installation of steam condensate piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Support pumps and piping separately so piping is not supported by pumps.
- D. Install pumps on concrete bases. Anchor pumps to bases using inserts or anchor bolts.
- E. Install thermometers and pressure gages.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Install steam supply for pressure-powered pumps as required by Division 23 Section "Steam and Condensate Heating Piping."

- D. Install gate and check valves on inlet and outlet of pressure-powered pumps.
- E. Install check valve, gate valve, and globe valve at pump discharge connections for each electric-driven pump.
- F. Pipe drain to nearest floor drain for overflow and drain piping connections.
- G. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

- A. Verify that steam condensate pumps are installed and connected according to the Contract Documents.
- B. Complete installation and startup checks according to manufacturer's written instructions.
- C. Clean strainers.
- D. Set steam condensate pump controls.
- E. Set pump controls for automatic start, stop, and alarm operation.
- F. Perform the following preventive maintenance operations and checks before starting:
 - 1. Set float switches to operate at proper levels.
 - 2. Set throttling valves on pump discharge for specified flow.
 - 3. Check motors for proper rotation.
 - 4. Test pump controls and demonstrate compliance with requirements.
 - 5. Replace damaged or malfunctioning pump controls and equipment.
 - 6. Verify that pump controls are correct for required application.
- G. Start steam condensate pumps according to manufacturer's written startup instructions.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 232223

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

1.4 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
 - 1. Thermostatic expansion valves.
 - 2. Solenoid valves.
 - 3. Hot-gas bypass valves.
 - 4. Filter dryers.
 - 5. Strainers.
 - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Shop Drawing Scale: 1/4 inch equals 1 foot.
 - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
- C. Welding certificates.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

- A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.
- B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.

- C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
- D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Flanged Unions:
 - 1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
 - 2. Gasket: Fiber asbestos free.
 - 3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
 - 4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
 - 5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 6. Pressure Rating: Factory test at minimum 400 psig.
 - 7. Maximum Operating Temperature: 330 deg F.
- F. Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket.
 - 2. End Connections:
 - a. NPS 2 and Smaller: With threaded-end connections.
 - b. NPS 2-1/2 and Larger: With flanged-end connections.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 - 3. Operator: Rising stem and hand wheel.
 - 4. Seat: Nylon.
 - 5. End Connections: Socket, union, or flanged.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and [] [115] []-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

- G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 5. Suction Temperature: 40 deg F.
 6. Superheat: Nonadjustable.
 7. Reverse-flow option (for heat-pump applications).
 8. End Connections: Socket, flare, or threaded union.
 9. Working Pressure Rating: 700 psig.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 3. Packing and Gaskets: Non-asbestos.
 4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 5. Seat: Polytetrafluoroethylene.
 6. Equalizer: Internal.
 7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 115-V ac coil.
 8. End Connections: Socket.
 9. Throttling Range: Maximum 5 psig.
 10. Working Pressure Rating: 500 psig.
 11. Maximum Operating Temperature: 240 deg F.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
 2. Screen: 100-mesh stainless steel.
 3. End Connections: Socket or flare.
 4. Working Pressure Rating: 500 psig.
 5. Maximum Operating Temperature: 275 deg F.
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
 2. Drain Plug: Brass hex plug.
 3. Screen: 100-mesh monel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.
 6. Maximum Operating Temperature: 275 deg F.
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 3. Indicator: Color coded to show moisture content in ppm.
 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

5. End Connections: Socket or flare.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 240 deg F.
- L. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240 deg F.
- M. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 3. Desiccant Media: Activated charcoal.
 4. Designed for reverse flow (for heat-pump applications).
 5. End Connections: Socket.
 6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
 7. Maximum Pressure Loss: 2 psig.
 8. Working Pressure Rating: 500 psig.
 9. Maximum Operating Temperature: 240 deg F.
- N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or flare.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 deg F.
- O. Receivers: Comply with ARI 495.
1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
 2. Comply with UL 207; listed and labeled by an NRTL.
 3. Body: Welded steel with corrosion-resistant coating.
 4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
 5. End Connections: Socket or threaded.
 6. Working Pressure Rating: 500 psig.
 7. Maximum Operating Temperature: 275 deg F.
- P. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.

2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Atofina Chemicals, Inc.
 2. DuPont Company; Fluorochemicals Div.
 3. Honeywell, Inc.; Genetron Refrigerants.
 4. INEOS Fluor Americas LLC.
- B. ASHRAE 34, R-22: Monochlorodifluoromethane.
- C. ASHRAE 34, R-134a: Tetrafluoroethane.
- D. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
- E. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-22

- A. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
 2. NPS 1-1/2 and Smaller: Copper, Type ACR L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 3. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 4. NPS 4: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- D. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
- E. Safety-Relief-Valve Discharge Piping: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping:

1. NPS 1-1/2 and Smaller: Copper, Type ACR L, drawn-temper tubing and wrought-copper fittings with brazed joints.
2. NPS 2 to NPS 3: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
3. NPS 4: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-134a

- A. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 1. NPS 1-1/2 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
 2. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 3. NPS 4: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- D. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
- E. Safety-Relief-Valve Discharge Piping: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping:
 1. NPS 1-1/2 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 2. NPS 4: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.3 PIPING APPLICATIONS FOR REFRIGERANT R-407C

- A. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 1. NPS 1 and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.
 2. NPS 1 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3. NPS 1-1/4 to NPS 2: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 4. NPS 4: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- D. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
- E. Safety-Relief-Valve Discharge Piping: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- F. Safety-Relief-Valve Discharge Piping:
1. NPS 1 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 2. NPS 4: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- 3.4 PIPING APPLICATIONS FOR REFRIGERANT R-410A
- A. Hot-Gas and Liquid Lines: Copper, Type ACR L, annealed or drawn temper tubing and wrought-copper fittings with brazed or soldered joints.
- B. Hot-Gas and Liquid Lines: Copper, Type K, annealed or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
- C. Hot-Gas and Liquid Lines: Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- D. Hot-Gas and Liquid Lines: Copper, Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
1. NPS 5/8 and Smaller: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 2. NPS 3/4 to NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.
 3. NPS 1-1/4 and Smaller: Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
 4. NPS 1-1/2 to NPS 2: Copper, Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- G. Safety-Relief-Valve Discharge Piping: Copper, Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- H. Safety-Relief-Valve Discharge Piping NPS 2 to NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.

3.5 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - 1. Solenoid valves.
 - 2. Thermostatic expansion valves.
 - 3. Hot-gas bypass valves.
 - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.6 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss,

expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

- Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.
 - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 - 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- R. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- S. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- U. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- V. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
- W. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.7 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- H. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.8 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 4. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- E. Support multifloor vertical runs at least at each floor.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.10 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.11 ADJUSTING

- A. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- B. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- D. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS.

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following water treatment for closed-loop hydronic systems:
 - 1. Manual chemical-feed equipment.
 - 2. Chemicals.
- B. Related Requirements:
 - 1. Section 232533 "HVAC Makeup-Water Filtration Equipment" for water softeners, RO equipment, and filtration equipment.

1.3 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- B. RO: Reverse osmosis.
- C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
 - 1. Bypass feeders.
 - 2. Water meters.
 - 3. Inhibitor injection timers.
 - 4. pH controllers.
 - 5. TSS controllers.
 - 6. Chemical solution tanks.
 - 7. Injection pumps.
 - 8. Chemical test equipment.
 - 9. Chemical material safety data sheets.

- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- C. Field quality-control reports.
- D. Other Informational Submittals:
 - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
 - 2. Water Analysis: Illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.8 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
 - 1. Initial water analysis and HVAC water-treatment recommendations.

2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or comparable:
 1. Ampion Corp.
 2. Anderson Chemical Company.
 3. Aqua-Chem, Inc.
 4. Barclay Water Management, Inc.
 5. Boland.
 6. Cascade Water Services, Inc.
 7. Earthwise Environmental Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including hot-water heating, chilled water, and glycol cooling shall have the following water qualities:
 1. pH: Maintain a value within 9.0 to 10.5.
 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 3. Boron: Maintain a value within 100 to 200 ppm.
 4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 6. TSS: Maintain a maximum value of 10 ppm.
 7. Ammonia: Maintain a maximum value of 20 ppm.
 8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 9. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.

- c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
- d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
- e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
 - 1. Capacity: 5 gal..except provide 10 gal for chilled water.
 - 2. Minimum Working Pressure: see drawings for minimum pressure requirements.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

- A. Water Meter:
 - 1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
 - 2. Body: Bronze.
 - 3. Minimum Working-Pressure Rating: 150 psig (1035 kPa).
 - 4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
 - 5. Registration: Gallons (Liters) or cubic feet (cubic meters).
 - 6. End Connections: Threaded.
 - 7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
 - 8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Water Meter:
 - 1. AWWA C701, turbine-type, totalization meter.
 - 2. Body: Bronze.
 - 3. Minimum Working-Pressure Rating: 100 psig (690 kPa).
 - 4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).
 - 5. Registration: Gallons (Liters) or cubic feet (cubic meters).
 - 6. End Connections: Threaded.
 - 7. Control: Low-voltage signal capable of transmitting 1000 feet (305 m).
 - 8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Water Meter:
 - 1. AWWA C701, turbine-type, totalization meter.
 - 2. Body: Bronze.
 - 3. Minimum Working-Pressure Rating: 150 psig (1035 kPa).
 - 4. Maximum Pressure Loss at Design Flow: 3 psig (20 kPa).

5. Registration: Gallons (Liters) or cubic feet (cubic meters).
6. End Connections: Flanged.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: [30 gal. (114 L)] [50 gal. (189 L)] [120 gal. (454 L)] <Insert value>.

E. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

G. Injection Assembly:

1. Quill: Minimum NPS 1/2 (DN 15) with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece, stainless steel; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig (4137 kPa) at 200 deg F (93 deg C).

2.5 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install water testing equipment on wall near water chemical application equipment.
- D. Install interconnecting control wiring for chemical treatment controls and sensors.
- E. Mount sensors and injectors in piping circuits.
- F. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, chilled water and glycol cooling, and equipped with the following:
 - 1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
 - 2. Install water meter in makeup-water supply.
 - 3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
 - 4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
 - 5. Install a swing check on the inlet after the isolation valve.

3.3 CONNECTIONS

- A. Where installing piping adjacent to equipment, allow space for service and maintenance.
- B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."
- C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."
- D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

- E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 - 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. At six-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- F. Comply with ASTM D 3370 and with the following standards:
 - 1. Silica: ASTM D 859.

2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.
- B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 232513

SECTION 233000 – DUCTWORK AND DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Sheet metal ductwork and fittings
 - 2. Sheet metal casings and plenums
 - 3. Duct Accessories; including dampers, flexible connectors, flexible duct, access doors
 - 4. Air volume control boxes
- B. Related Sections include the following:
 - 1. Duct mounted smoke detectors are specified in Division 28
 - 2. Airflow measuring stations are specified in Division 23
 - 3. Motorized control dampers are specified in Division 23
 - 4. Duct mounted filters are specified in Section 23 41 00, "Air Filtration"

1.3 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For acoustically lined ducts and casings, maintain sizes inside lining. For rectangular ductwork in plan, first dimension indicates width and second dimension indicates height.
- B. Pressure Class: The numerical duct construction pressure classification that identifies permissible SMACNA Duct Construction Standards.
- C. Seal Class: Identifies the extent of sealing of duct joints, seams and penetrations per SMACNA Duct Construction Standards.
- D. Leakage Class: Identifies permissible leakage as described in SMACNA HVAC Air Duct Leakage Test Manual.
- E. Low Pressure Ductwork: 3 inch wg and less.
- F. Medium Pressure Ductwork: 4 inch wg and 6 inch wg.
- G. High Pressure Ductwork: Greater than 6 inch wg.

1.4 REFERENCES

- A. SMACNA: HVAC Duct Construction Standards – Metal and Flexible

- B. SMACNA: HVAC Air Duct Leakage Manual
- C. ARI 880: Air Volume Terminals
- D. UL: Applicable Standards

1.5 SUBMITTALS

- A. Product Data:
 - 1. Provide booklet of Shop Standards, including the following:
 - a. Duct construction classification and fabrication, assembly, and installation details including SMACNA Tables and Figure numbers clearly marked to identify which are to be used.
 - b. Details of shop fabricated items, fittings, reinforcing details and spacing, seam and joint construction.
 - c. Installation details of duct mounted equipment and accessories, including dampers, coils, access doors, hangers and supports.
 - d. Product data for factory fabricated equipment, dampers, access doors, flexible duct, etc.
 - 2. For each type of product indicated, include performance characteristics, rated capacities, data sheets, and furnished accessories.
 - 3. Shop standards shall be submitted for review prior to submission of sheet metal shop drawings. Any sheet metal shop drawings submitted prior to the shop standard review will be returned as "Rejected".
- B. Product Schedule or Lists: Include Diffuser, Register and Grille Schedule, indicating Drawing designation, room location, quantity, model number, size and accessories furnished.
- C. Shop Drawings: Prepare CAD-generated shop fabrication drawings to a scale of not less than 3/8 inch per foot. Show complete ductwork and casing layout, including:
 - 1. Duct layout indicating sizes and pressure classes.
 - 2. Elevations of top and bottom of ducts.
 - 3. Dimensions of main duct runs from building grid lines.
 - 4. Fittings.
 - 5. Clearly show all duct accessories, including access doors, dampers, diffusers and grilles.
 - 6. Acoustical lining and thickness as applicable.
 - 7. Prepare duct layout based on routing indicated on the drawings, and make reasonable modifications to layout without increasing duct system pressure drop in order to coordinate with other trades. Refer to "Layout and Coordination with other Trades" specified in Section 23 05 00. Do not submit duct shop drawings until multi-discipline coordination drawings specific in Division 1 are completed.
 - 8. Clearly identify by circle and by note "Deviation" and/or "Interference" in large lettering any and all deviations from Drawings and any and all unresolved

- interference conditions and assume full responsibility for failure to do so.
9. Submit all shop drawings for review. The Architect will review only the circled and noted deviation(s) or interference(s). The Architect will not review and will return without review submittals, or portions thereof, which have no deviation(s) or interference(s) clearly noted.
 10. Modify shop fabrication drawings in accordance with Architect's review comments, if any, and to show any subsequent shop or field changes. At completion of work, submit final shop fabrication drawings labeled "As-Built" to the Owner for record purposes.
- D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-- Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Ch. 3, "Duct System," for range hood ducts, unless otherwise indicated.

1.7 COORDINATION

- A. Coordinate location of duct access doors to allow proper access to dampers, coils, fans, etc. Coordinate with General Contractor proper location of wall and ceiling access panels to permit access to duct access doors.
- B. Coordinate location of duct mounted equipment (coils, humidifiers, filters, smoke detectors) furnished in other Sections for installation under this Section. Provide duct transitions as required.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; zinc coating each side, complying with ASTM A653/A653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

- C. PVC-Coated Galvanized Steel: Acceptable by authorities having jurisdiction for use in fabricating ducts with UL 181, Class 1 listing. Lock-forming-quality, galvanized sheet steel complying with ASTM A653/A653M and having G60 coating designation. Factory-applied PVC coatings shall be 4 mils thick on sheet metal surfaces of ducts and fittings exposed to corrosive conditions and 2 mils thick on opposite surfaces.
- D. Carbon-Steel Sheets: ASTM A366/A366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.
- E. Stainless Steel: ASTM A480/A480M, Type 304, and having a No. 2D finish for concealed ducts and No. 4 satin finish for exposed ducts. Use low carbon content material where welded joints are specified.
- F. Aluminum Sheets: ASTM B209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- G. Reinforcements: Structural shapes (channels, angles, and plates) shall be of galvanized steel where installed on galvanized ducts, and Type 304 stainless steel where installed on stainless steel ducts.

2.2 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Comply with NFPA 90A or NFPA 90B.
 - 1. Acceptable Manufacturer, no substitution:
 - a. Armacell
 - 2. Materials: Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C534, Type II, except for density.
 - a. Thickness: 1/2 inch.
 - b. Thermal Conductivity (k-Value): 0.24 at 75 deg F mean temperature.
 - c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C411.
 - d. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.3 SEALANT MATERIALS

- A. Acceptable Manufacturers:
 - 1. United McGill Corp.
 - 2. H.B. Fuller Co., Foster Products Division
 - 3. Precision Adhesives
 - 4. Carlisle Hardcast
 - 5. General Electric Co.

B. General:

1. The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
2. Sealants for air distribution systems shall be of liquid and/or mastic type in accordance with SMACNA.

C. All sealants shall be UL Classified and meet NFPA 90A, Class 1 requirements when applied in a manner consistent with its intended use. Ratings shall not exceed a Flame Spread of 25 or a Smoke Developed of 50. All containers and shipping cartons shall bear the UL label indicating flame and smoke ratings and shall include Fire Hazard Classification. Labeling shall also include Hazard Statement required by the Consumers Product Safety Act, CFR Title 16, Chapter II, subchapter C, Federal Hazardous Substances Act Regulations, Part 1500, Section 1-272.

D. Sealants for air distribution systems shall be compatible with the materials, application and operating temperatures of the system. Sealants used for systems handling fumes and chemicals shall be confirmed suitable for the specific application. Sealants used for systems serving clean rooms shall be FDA approved silicone sealant. Sealants exposed to the weather, shall be ultraviolet light and ozone resistant and provide watertight seal.

E. Sealants shall be applied in accordance with manufacturer's instructions. Provide adequate ventilation and follow safety procedures as required. Adequate drying/curing time shall be allowed before operating or testing the systems.

F. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

G. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

H. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use O.

I. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 DUCT PRESSURE CLASSIFICATION AND CONSTRUCTION

A. Construct ducts for pressure class indicated (positive or negative), and seal all seams and joints to achieve Seal Class A, Leakage Class 6 for rectangular duct and Class 3 for round duct. See duct pressure classification schedule for additional requirements.

B. Material: All ducts shall be galvanized steel, except where specifically noted otherwise on drawings and as follows:

1. Ductwork at Humidifiers: Type 304 stainless steel 1 foot up stream and 3 ft foot down stream of humidifier. Welded seams and joints.
2. Cooking Exhaust Ducts: Comply with NFPA 96
 - a. Exposed; 18 gauge Type 304 stainless steel, finish to match hood construction.
 - b. Concealed; Minimum 16 gauge carbon steel or 18 gauge Type 304 stainless steel. All joints and seams externally welded or soldered liquid tight.
3. Dishwasher Exhaust Ducts: Aluminum. Make all joints through which condensed moisture may leak watertight by welding or soldering.
4. Exposed Exhaust Connections to Stainless Steel Canopy Hoods: Stainless steel to match hood construction. Welded joints.
5. Shower Exhaust Ducts: Aluminum.
6. Laundry Exhaust Ducts: Aluminum.
7. Laboratory Acid-Resistant (Fume-Handling) Ducts:
 - a. Type 304, stainless-steel sheet.
 - b. PVC-coated galvanized steel with thicker coating on duct interior.
 - c. Flanged Joint Gaskets: PVC of 35 to 40 durometer or equivalent corrosion resistant material.
8. Cart Wash Equipment Exhaust: Type 304 stainless steel, welded seams and joints.
9. MRI Supply, Return and Exhaust: Aluminum.
10. Ductwork located outdoors above ground and not specified to be insulated or to be stainless steel: Aluminum.

2.5 GENERAL DUCT FABRICATION

- A. Detail and fabricate with the fewest possible joints in accordance with SMACNA standards and details, except where more stringent requirements are specified in this section, to keep resistance losses to a minimum.
- B. Size round ducts installed in place of rectangular ducts, and vice versa, from ASHRAE table of equivalent rectangular and round ducts. Aspect ratio of rectangular ducts can be modified for coordination of layout, but in no case exceed 4 to 1, and without reducing free area of duct or increasing pressure drop.
- C. Complete metal ducts within themselves with no single partition between ducts. Open corners are not acceptable.
- D. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.
- E. Sleeves:
 1. Construct sleeves of galvanized steel minimum 22 gauge unless noted otherwise.
 2. Provide sleeves for fire dampers and combination fire/smoke dampers as specified in this Section "Fire and Smoke Dampers".

- a. Breakaway connections are not permitted except for pressure class 2-inch wg and less.
- F. Square heel and throat elbows, with vanes, are used on Drawings for drafting convenience only. Where space allows, construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible on rectangular ductwork, provide smooth radius elbows with full length splitter vanes designed and constructed in accordance with SMACNA Duct Design and Duct Construction Standard to produce a loss coefficient of 0.15 or less, except as follows:
1. Where R/W is such that a vaned radius elbow will not produce the specified loss coefficient and on exposed ductwork in finished areas, provide mitered elbows with square heel and throat and with double thickness turning vanes set into vane runners designed and constructed to produce a loss coefficient of 0.26 or less in accordance with above standards.
 2. Increase/decrease duct sizes gradually, not exceeding 15° divergence/ convergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.
- G. Unless otherwise indicated or specified, fabricate branch connections as follows:
1. Rectangular duct branch connection to rectangular ductwork, 45° SMACNA entry/exit butt flange boot with corner filler pieces or proportional splits at Contractor's option. Where size of main duct is not large enough for a boot connection, fabricate ducts with proportional splits.
 2. Round duct branch connections to high and medium pressure round ductwork, conical tee.
 3. Round duct branch connection to low pressure round ductwork, conical tee or straight tee.
 4. Round branch connection to high and medium pressure rectangular ductwork, bellmouth connection equal to United McGill SRSBM.
 5. Round duct connection to rectangular duct on low pressure ductwork, bellmouth connection equal to Buckley BM or BMD or, for sizes 10 inches and smaller, straight connection equal to Buckley ATM or ATMD.
 6. Where round duct is connected to rectangular duct and rectangular duct width shown is not equal to or larger than overall diameter of connecting end of round connector BENDING OF FLANGES OF ROUND CONNECTOR FOR CONNECTION TO RECTANGULAR DUCT IS NOT ALLOWED. Either increase rectangular duct width as required or provide a rectangular 45° SMACNA boot connection to the rectangular duct and a rectangular to round conversion for the round duct connection. For round connection to low pressure ductwork. Contractor may, at his option use a mini bellmouth connection equal to Buckley M-BM or M-BMD or a flat oval bellmouth equal to Buckley FOBM or FOBMD and an oval to round conversion for the round duct connection.
 7. Spin-in, clinch lock or dovetail fittings not allowed except at duct connection to a transfer duct.
 8. Connect branch to top, bottom or side of duct as indicated or as required, whether or not indicated, to suit surrounding conditions and avoid interferences.
 9. Coordinate branch take-off locations with transverse joint spacing. Transverse joints interfering with branch take-offs will not be accepted. Modify joint spacing as

required without exceeding maximum spacing.

- H. Rigidly construct ducts with joints mechanically tight, substantially airtight without use of tape, braced and stiffened so as not to breathe, rattle, vibrate, or sag. Caulk duct joints and connections with sealant as ducts are being assembled. Where joints are not accessible for sealing, provide access doors and seal from inside.
- I. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10% duct area, split into two ducts maintaining original duct area. No easements or penetrations allowed for medium or high pressure ductwork.
- J. Fabricate goosenecks of aluminum equivalent to not less than 18 gauge galvanized steel. Rigidly reinforce and brace. Provide hinged 1/2 inch mesh aluminum hardware cloth bird screen. Fabricate for lowest edge of opening not less than 24 inches above finished surface of roof for exhaust, and 36 inches above roof for intakes.
- K. Cooking Exhaust: Use smooth radius elbows without vanes. Square heel and throat elbows, with or without vanes, will not be allowed on cooking (grease) exhaust ductwork. Turning vanes or other obstructions within the airstream where grease could collect are not permitted.

2.6 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 - 1. Construct ducts of minimum 26 gauge.
 - 2. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 - 3. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints, fastened to duct section with spot welds (do not use screws), and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement. Ductmate Industries, Inc., Nexus Inc., Ward Industries, Inc.
- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards- Metal and Flexible, 3rd Edition 2005 Figure 2-17 Corner Closures-Flanges", except that screws may not be used in lieu of metal clips and equivalent fixation of joints may not be used; use corner, bolt, metal clip and gasket details. Ductmate Industries, Inc. or Lockformer.
 - 1. Use joint reinforcing for T-24 or T-25 joints and sheet metal gauges as recommended by SMACNA Standards as a minimum. Do not use lighter gauges shown in joint manufacturer's literature.
- D. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant. Button punch

snaplocks and pocket locks are not permitted for ducts constructed of 2 inch wg or less.

- E. Cross Breaking or Cross Beading: For duct pressure class 3 inch or less, cross break or cross bead duct sides 18 inches and larger and 20 gauge thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.7 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

- A. Acceptable Manufacturer: Factory fabricated or shop fabricated but equal in all respects to factory fabricated items specified herein:
 - 1. McGill AirFlow Corporation.
 - 2. SEMCO Incorporated.
- B. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- C. Round Duct and Fittings: Lock type spiral seam construction of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Fabricate ducts larger than 50 inches diameter with longitudinal butt welded seam construction. Stamped elbows and fittings. Gored (segmented) elbows and fitting only for sizes where stamped elbows and fittings not available. Adjustable elbows are not permitted.
- D. Flat-Oval Duct and Fittings: Lock type spiral seam construction for minor axis through 20 inches in size according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible". Fabricate ducts larger than 20 inches in diameter with butt-welded longitudinal seams.
- E. Duct Joints:
 - 1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 - 2. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances. Ductmate Industries, Inc., Lindab, Inc. or equal.
 - 3. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket. Ductmate Industries, Inc., McGill Airflow Corporation, SEMCO Incorporated, or equal.
- F. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- G. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- H. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

- I. Plastic coated where specified.

2.8 DOUBLE-WALL DUCT AND FITTING FABRICATION

A. Acceptable Manufacturers:

1. Lindab, Inc.
2. McGill AirFlow Corporation
3. SEMCO Incorporated

B. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 1-inch-thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
 - a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
 - a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
 - b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.
 - c. Ducts 44 to 60 Inches in Diameter: 0.022 inch with single-rib spiral-seam construction.
 - d. Ducts 62 to 88 Inches in Diameter: 0.034 inch with standard spiral-seam construction.
4. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.
5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

C. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.

1. Solid Inner Ducts: Use the following sheet metal thicknesses:
 - a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
 - b. Ducts 35 to 58 Inches in Diameter: 0.034 inch.
 - c. Ducts 60 to 88 Inches in Diameter: 0.040 inch.
2. Perforated Inner Ducts: Fabricate with 0.028-inch-thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

2.9 FLEXIBLE DUCTWORK

- A. Acceptable Manufacturers: Type numbers indicated are those of Thermaflex.
 - 1. Thermaflex
 - 2. Flexmaster, Inc.
- B. UL listed under UL-181 as Class 1 Air Duct Connector and conforming to NFPA 90A and 90B.
- C. Minimum Rating: 10 inch WG positive all uses, 2 inch WG negative for return or exhaust use, velocity of 4000 feet per minute.
- D. For Heating-Cooling or Cooling Only Application: Type "MKC". Continuous galvanized spring wire helix having a cover of woven fiberglass fabric, vinyl impregnated and coated, or continuous corrugated aluminum for low pressure supply use only, and insulated with 1 inch thick fibrous glass insulation having outer moisture barrier consisting of reinforced metalized Mylar/ neoprene laminate with integral attaching devices. "U" factor at 75° F differential maximum 0.22 btu/sq.ft./° F/hour.
- E. Attachment: Duct clamp stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action in size to suit duct size.

2.10 HANGERS AND SUPPORTS

- A. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters. Perforated strap hangers are not allowed.
 - 3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
- B. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Hanger fasteners shall not pierce medium/high pressure (greater than 3 inches w.g.) ductwork under any circumstance.
- C. Trapeze and Riser Supports: Steel shapes complying with ASTM A36/A36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

2.11 FLEXIBLE CONNECTORS

- A. Acceptable Manufacturers
 - 1. Ductmate Industries, Inc.

2. Duro Dyne Corp.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or stainless steel, or 0.032-inch-thick aluminum sheets. Select metal compatible with connected duct system. Comply with SMACNA requirements.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd..
 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F.

2.12 SHOP AND FIELD FABRICATED CASINGS

- A. Fabricate casings according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible", except where more stringent requirements are specified herein.
- B. Shop fabricate casings, to greatest extent possible, with a minimum number of joints and to minimize field fabrication and assembly.
- C. Fabricate casings with standing seams and angle reinforcements. Reinforce casings with galvanized- or painted-steel angles. Seal joints with liquid-type, high-pressure duct sealant to eliminate air leakage.
- D. Fabricate casings with reinforced and braced openings for hinged access doors at least 24 inches wide by 48 inches high and located for access to each item of equipment housed, or where shown on drawings for cleaning and inspection. Provide double wall access door when installed in insulated plenums.

- E. Provide minimum 3 inch high reinforced concrete curb for floor mounted walls. At floor, rivet panels on 8 inch centers to steel angles.

2.13 FACTORY FABRICATED CASINGS

- A. Acceptable Manufacturers:
 - 1. Industrial Acoustics Company
 - 2. Vibro-Acoustics, Co.
 - 3. McGill Airflow Corporation
 - 4. Semco Incorporated
- B. Double-wall, insulated, pressurized equipment casing.
- C. Panel Fabrication: Solid, galvanized sheet steel exterior shell and solid, galvanized sheet steel interior shell; with 2- or 4-inch space between shells, as indicated.
 - 1. Fabricate with a minimum number of joints.
 - 2. Weld exterior and interior shells to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
 - 3. Exterior Shell Thickness: 0.040 inch minimum.
 - 4. Interior Shell Thickness: 0.034 inch minimum.
 - 5. Interior Shell Thickness: 0.034 inch minimum, with 3/32-inch perforations at 3/16-inch staggered spacing for 23 percent open area.
 - 6. Fabricate perimeter and interior, longitudinal channel members with galvanized-steel shapes.
 - 7. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant, and vermin proof, and that complies with NFPA 90A.
 - 8. Fabricate panels with tongue-and-groove, continuous self-locking joints effective inside and outside each panel.
- D. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.
- E. Access Doors: Fabricate personnel access doors at least 24 by 60 inches and other access doors in sizes indicated.
 - 1. Fabricate doors of same thickness as panels, with a minimum 0.040-inch solid, interior and exterior, galvanized sheet steel shell.
 - 2. Install a minimum of two ball-bearing hinges and two wedge-lever-type latches, operable from inside and outside. Install doors to open against air pressure differential. Install neoprene gaskets around entire perimeters of door frames.
 - 3. Fabricate windows in doors consisting of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
- F. Structural Performance: Fabricate plenum to be self-supporting and capable of withstanding internal static pressures as scheduled, without any panel joint exceeding deflection of L/200

where "L" is the unsupported span length within completed casings.

- G. Acoustic Performance: Certified by an independent acoustical testing agency listing sound-absorption and transmission-loss characteristics of panel assemblies.
- H. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

2.14 VOLUME DAMPERS

- A. General: Factory fabricated, or shop fabricated but equal in all aspects to factory fabricated items, with required hardware and accessories in accordance with SMACNA duct standards except as noted herein.
- B. Damper and damper frames shall be constructed of same material as duct in which they are installed. Fabricate single blade damper of minimum 20 gauge. Fabricate multi-blade damper of minimum 16 gauge.
- C. Damper blades in rectangular ductwork shall be maximum 8 inches wide. Dampers having two or more blades shall be opposed action type with connecting bar and linkage. Multiple blade dampers shall be mounted in frames. Splitter dampers not allowed.
- D. Provide for multiple section damper (larger sizes), appropriately sized jackshaft with bearing assemblies mounted on supports at each mullion and at each end of the multiple damper section. Provide appropriate length and number of mountings to connect linkage of each damper to the jackshaft.
- E. Stiffen blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Device shall include indication of damper position. Provide end bearings and gaskets for damper components to seal duct consistent with pressure class.
- F. Damper Hardware: Dampers shall be provided with all hardware including zinc plated, die-cast core with dial and handle made of 3/32 inch thick zinc plated steel, and a 3/4 inch hexagon locking nut. Include center hole to suit damper operating rod size. Include raised quadrant for mounting on insulated duct. Improvised shop or field fabricated hardware will not be accepted.

2.15 REMOTE CEILING DAMPER REGULATOR

- A. Acceptable Manufacturers, no substitutions:
 - 1. Young Regulator
- B. System specifically designed for remote manual adjustment of duct mounted volume damper.
- C. Damper controller and cable shall be concealed above the ceiling and wall. Cable to consist of Bowden cable 0.054-inch stainless steel control wire encapsulated in 1/16 inch flexible galvanized spiral wire sheath. Maximum 50 feet length of cable distance between damper and control kit.

D. Damper:

1. Round damper constructed of heavy duty galvanized steel spiral shell design with rolled in stiffening beads for rigidity. Spiral shell shall have one crimped end and one straight end for ease of installation. Damper to include "V" style 20 gauge galvanized steel blade secured with ½ inch diameter steel shaft and Teflon bushings. Young Regulator Model 5020-CC.
2. Rectangular damper to be opposed blade type constructed of heavy duty extruded aluminum frame and blades. Damper blades to include individual blade bushings for smooth and quiet operation. Damper blades shall rotate between a matched pair of formed and punched stainless steel connecting slide rails that facilitate blade movement and alignment. Young Regulator Model 830A-CC.
3. Damper shall include all necessary hardware to ensure compatibility with Bowden remote cable control system.

E. Control Shaft: Shall be D-styled flatted ¼ inch diameter with 265 degree rotation providing graduations for positive locking and control, and 1 ½ inch linear travel capability.

F. Control Kit: Shall consist of 2 5/8 inch diameter die cast aluminum housing with 3 inch diameter zinc plated cover plate, and 14 gauge steel rack and pinion gear drive converting rotary motion to push-pull motion. Control kit is designed to be concealed in the ceiling flush with the finished surface. Include wrench for damper adjustment. Young Regulator Model 270-301.

G. Control Kit: Shall be designed for use with internally or externally controlled round or rectangular dampers and shall consist of 14 gauge steel rack and pinion gear drive converting rotary motion to push-pull motion. Control kit mounting bracket can be field mounted on ceiling framework, behind grilles, on or inside plenum slot diffusers, or on diffuser back pan. Include wrench for damper adjustment. Young Regulator Model 270-275.

H. Control Kit: Shall consist of 2 5/8 inch diameter die cast aluminum housing with 3 inch diameter zinc plated cover plate, and 14 gauge steel rack and pinion gear drive converting rotary motion to push-pull motion. Control kit is designed to be concealed in the wall flush with the inside surface. Include wrench for damper adjustment. Young Regulator Model 270-302.

2.16 BACKDRAFT DAMPERS

A. Acceptable Manufacturers:

1. Ruskin
2. Greenheck
3. Air Balance, Inc.

4. American Warming and Ventilating Co.

B. Low Pressure Backdraft Damper:

1. Factory fabricated, heavy-duty, multiblade, parallel action gravity balanced backdraft damper with minimum 0.050 inch aluminum blades a maximum of 6 inch width having flexible vinyl sealing edges, linked together in rattle-free manner and with adjustment device to permit setting for varying differential static pressure. Blade pivot pins mounted in nylon bearings in a minimum 0.050 inch extruded aluminum mounting frame. Constructed for up to 1500 feet per minute face velocity and 1/2 inch water gauge static pressure. Suitable for horizontal or vertical applications as indicated.
2. Provide minimum 0.050-inch extruded aluminum wall frame with mounting flange for wall mounted damper.

C. High Pressure Backdraft Damper:

1. Factory fabricated, heavy-duty, multiblade, parallel action, gravity balanced backdraft damper with airfoil blades a maximum of 6 inch width having flexible vinyl sealing edges and neoprene jamb seals.
2. Pressure drop for a 24 inch x 24 inch damper shall not exceed 0.2 inch water gauge when tested in accordance with AMCA Standard 500, Figure 5.3 with ductwork upstream and downstream of damper.
3. Blades interconnected with on-blade linkage. Provide external counterbalance on extended shaft, field adjustable for system flow and pressure.
4. Minimum 14 gauge, galvanized steel, 8 inch by 2 inch formed channel frame with minimum 18 gauge galvanized blades mounted on minimum 3/4 inch zinc plated shafts rotating in 3/4 inch bore ball bearings. Designed for up to 4,500 feet per minute face velocity and 7 inches water gauge static pressure for Class 2 fans.

2.17 FIRE AND SMOKE DAMPERS

A. Acceptable Manufacturers:

1. Ruskin
2. Greenheck
3. Pottorff

- B. General: All dampers operable at pressures and velocities required by systems in which installed. Provide single or multiple framed assemblies as required for size of duct in which installed in order to maintain UL listing of entire damper assembly.

C. Fire Damper (FD):

1. General: Fire dampers shall be UL labeled, constructed in accordance with UL 555.
2. Rating: 1 ½ hour for use in rated walls 2 hours and less, otherwise 3 hour.
3. Link: Provide replaceable fusible link rated for 165 deg F, except 212 deg F where indicated.
4. Materials: Galvanized steel, except stainless steel for installation in stainless steel,

aluminum, or plastic coated ductwork. Provide rectangular to round adapter when installed in round duct.

5. Sleeve: Factory installed as part of damper assembly furnished by manufacturer, or field fabricated and installed. Construct sleeves for rigid connection to adjoining ductwork in accordance with UL 555 as follows:
 - a. Dampers less than 24 inches, 16 gauge
 - b. Dampers 24 inches and greater, 14 gauge
 - c. Use heavier gauges if required by SMACNA construction standards for pressure class indicated.
6. Type:
 - a. Fire dampers for transfer air application shall be shutter type for vertical mounting only.
 - b. Fire dampers for other than air transfer, and other than listed below, shall be curtain blade type with closure spring to assure positive closure for either horizontal or vertical mounting with "fans on". Blades retained in a recess out of the air stream, including multiple section applications.
 - c. Fire dampers with longest dimension less than 24 inches, or where UL sizing limitations will not permit the use of a curtain blade damper, or elsewhere as indicated, shall be multi-blade type spring loaded to assure closure for either horizontal or vertical mounting with "fans on". Blades shall be single skin 16 gauge with V-groove airfoil blade reinforcement. Damper linkage rod extended to outside of frame. Bearings shall be stainless steel sleeve in an extruded hole.

D. Smoke Damper (SD):

1. General: Smoke damper and motor assembly shall be UL labeled, constructed in accordance with UL 555S.
2. Materials: Galvanized steel, except stainless steel for installation in stainless steel, aluminum, or plastic coated ductwork. Factory installed sleeve as part of damper assembly.
3. Parallel airfoil blade type with 24 volt, single phase electric motor. Two position motor, fail closed position upon loss of power.
4. Smoke dampers for air handling unit supply and return and elsewhere as indicated as having a damper end switch("es") shall include factory mounted blade position switch.
5. Leakage Class: Class II, except Class I for smoke control systems and elsewhere as indicated.

E. Combination Fire/Smoke Damper (FD/SD):

1. General: Combination fire and smoke damper shall be UL labeled, for 1 ½ hour fire rating.
2. Materials: Galvanized steel, except stainless steel for installation in stainless steel, aluminum, or plastic coated ductwork. Factory installed sleeve as part of damper assembly.
3. Provide manually resettable electric heat sensing device rated for 165 deg F.
4. Parallel airfoil blade type with 24 volt, single phase electric motor. Two position motor operation fail closed position upon loss of power.

5. Leakage Class: Class II, except Class I for smoke control system and elsewhere as indicated.
6. Combination Fire/Smoke Dampers used for air handling unit isolation, and indicated elsewhere as having damper end switch(es), shall include factory mounted blade position switch.
7. Provide remote key activated damper test switch.

2.18 DUCT SOUND ATTENUATORS

- A. Acceptable Manufacturers:
 1. Vibro-Acoustics Company
 2. Dynasonics
 3. Semco
 4. Ruskin
- B. General: Factory fabricated and tested, rectangular, round, or elbow duct silencer with performance characteristics as indicated.
- C. Fire Performance: Adhesives, sealants, and packing materials shall have fire ratings not exceeding 25 for flame spread index and 50 for smoke developed index when tested according to ASTM E84.
- D. Rectangular and Round Units: Fabricate outer casing with a minimum 22 gauge solid galvanized steel, and inner casing with a minimum 26 gauge perforated galvanized steel. 1/8 inch diameter perforations for inner casing and baffles.
- E. Elbow Units: Fabricate outer casing with a minimum 18 gauge solid galvanized steel, and inner casing with a minimum 22 gauge perforated galvanized steel.
- F. Fabricate to form rigid unit that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Unit shall not experience air leakage up to differential pressure of 6 inch wg from inside to outside. Seams and joints lock formed and sealed or continuously welded. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
- G. Fill Material: Provide with the following as indicated:
 1. Inert and vermin-proof fibrous material, packed under not less than 5 percent compression, mylar lined resistant to erosion.
- H. Source Quality Control: Factory test according to ASTM E477. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000 fpm face velocity. Test methods shall eliminate effects due to test room conditions. Published performance data shall include all octave bands (63 Hz to 8000 Hz).
- I. Performance: The dynamic insertion loss in decibels (dB) shall not be less than that scheduled on drawings throughout all octave bands.

2.19 ACCESS DOORS

- A. General: Factory fabricated double wall access doors in accordance with SMACNA standards except as specified herein. Improvised shop or field fabricated access doors will not be permitted.
- B. Fabricate doors airtight and suitable for duct pressure class. Access doors shall be double wall constructed of the same material as the ductwork in which they are installed except that doors located in ducts constructed of plastic, FRP and PVC coated steel shall be constructed of Type 304 stainless steel.
- C. Rectangular Duct: Provide door with closed cell full sealing gaskets and quick turn fastening locking device. Provide hinged doors with butt or piano hinge and 2 cam latches. For medium and high pressure duct, hingeless with minimum 4 cam latches and factory installed retaining cable.
- D. Round Duct: Provide double wall insulated and gasketed door with minimum 2 compression latches.
- E. For insulated ductwork, fabricate double wall with insulation fill and thickness not less than adjacent duct insulation. Provide raised hinge type.
- F. Construct access doors in grease duct in accordance with the more stringent requirements of NFPA 96 and SMACNA.
- G. Access door size 16 inches by 20 inches unless otherwise indicated. Where size of duct will not accommodate this size, provide size as large as possible, minimum 12 inch by 6 inch. Provide view window where indicated.

2.20 INSTRUMENT TEST HOLES

- A. Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pitot tube and other testing instruments and provide in length to suit duct insulation thickness. Ventlock 699 by Ventfabrics, or approved equal.

2.21 DUCT ROOF CURBS

- A. Welded galvanized steel, insulated mounting curb without cant strip and with treated wood nailer suitable for duct roof penetration. Fibrous glass insulation minimum 1 ½ inches thick. Curb height as required for top of curb not less than 12 inches above finished roof surface. As manufactured by ThyCurb, Pate, Penn Ventilator, or equal.
- B. Furnish roof curb to Division 07 for installation.

2.22 BARRIER WRAP

- A. Acceptable Manufacturers:

1. Sound Seal

- B. General: Provide combination of limp, flexible loaded vinyl noise barriers permanently factory laminated to a polyester urethane absorption foam. System to meet 25/50 Flame /Smoke Spread Requirements,
- C. The limp mass barrier shall be barium sulphate loaded, unreinforced PVC material, nominally weighing 0.5 or 1.0 lbs/sq ft.
- D. The bonded absorption or decoupling layer shall be 2 PCF density, polyester urethane, flexible, acoustical foam have a Noise Reduction Coefficient (NRC) of 0.27 for ¼ inch, 0.49 for ½ inch and 0.73 for 1 inch thicknesses when used as a limited length, free hanging barrier with foam facing the noise source.
- E. Composite materials shall have following minimum transmission loss when adhered to 18 gauge sheet metal and set into test according to ASTM E336 or E90.

Sound Transmission Loss (dB)						
Frequency (Hz)						
25	250	500	1000	2000	4000	STC

18	18	23	30	39	46	29
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- F. Material for lapping joints same as limp mass barrier. Adhesive for laminating layers of barrier material shall be as recommended by manufacturer of the barrier material. Coordinate with duct insulation material and installation.

2.23 AIR VOLUME CONTROL BOXES

A. Acceptable Manufacturers:

1. JCI
2. Price Industries
3. Anemostat
4. Tuttle & Bailey
5. Titus
6. Nailor Industries
7. Trane
8. Enviro-Tec

B. General:

1. Factory fabricated assembly consisting of casing, damper, airflow sensor and other accessories as specified herein.
2. The assembly operation shall be pressure independent and shall reset to any airflow throughout entire operating range.
3. Performance ratings shall be certified in accordance with ARI 880 and shall bear the ARI seal. Sound ratings calculated in accordance with ARI 885.
4. Identification: Provide label on each box indicating identification number shown on drawings, maximum and minimum airflow range, scheduled airflow and calibration curve.

C. Configuration:

1. Boxes shall be suitable for electric powered pressure independent air volume control system and temperature control system furnished by Division 23 BAS Contractor. Boxes shall include airflow sensor and damper with extended shaft compatible with unit mounted controller.
2. Division 23 BAS Contractor will ship controller to box manufacturer who shall install controller and damper actuator at factory prior to shipment.

D. Casing:

1. Minimum 22 gauge galvanized steel housing. Inlet collar minimum 2 inch depth for securing duct connection. Outlet slip and drive connection.
2. Provide insulated double wall access door or removable panel for access to all interior components and coil cleaning.
3. Provide sheet metal frame in box casing and gasket seal to obtain specified maximum leakage.

4. Standard casing: Construct and seal casing and access panel for leakage not to exceed 2% of unit rated airflow, or 10 CFM, whichever is greater, at 1.5 inch w.g. static pressure.

E. Insulation:

1. Fibrous glass: 1/2 inch thick 1½ pound density fibrous glass insulation, coated with a durable fire and damage resistant surface to prevent erosion complying with ASTM C1071; secured with adhesive. All exposed edges shall be coated.
2. Polymer foam: For use on operating rooms and other AHU supply air temperature of 50°F or lower. ¾ inch thick closed cell polymer foam, complying with UL 181 erosion requirements, and having maximum flame spread index of 25 and maximum smoke developed index of 50, for both insulation and adhesive, when tested according to ASTM E84.
3. The unit insulation shall be fully enclosed with non-porous foil liner. All edges sealed within metal nosing or with NFPA 90A approved sealant.

F. Damper:

1. Damper constructed of two heavy gauge metal plates sandwiched around gasketed blade seal with solid one piece aluminum shaft rotating in self lubricated bearings extended outside of unit casing. Construct of materials that cannot corrode and do not require periodic servicing. Hollow metal shaft is not permitted.
2. Provide damper blade seals and shaft bearing bushings to satisfy required leakage. Damper shaft shall include an integral marker at the end of shaft to indicate damper position.
3. Damper leakage for closed damper shall not exceed 2% of the nominal catalog rating at 3- inch w.g. inlet pressure. ARI 880 rated.

G. Air Flow Sensor:

1. Center tapped cross flow averaging sensor located in inlet collar, constructed of plastic meeting UL fire resistance, reinforced to prevent damage.
2. Sensor shall amplify pressure signal by a factor of not less than 1.75 and shall maintain control accuracy within plus or minus 5% throughout operating range with the same size inlet duct in any configuration. Sensor shall not require any minimum length of straight duct to maintain control accuracy.
3. Sensor shall have a minimum of 16 pressure measurement points on all inlet sizes. Pressure sensing tubes shall be extended to the outside of casing for connection to the airflow controller. Tubing secured to casing with grommets.
4. Sensor shall be aerodynamically designed with negligible pressure drop or noise contribution.

H. Hot Water Heating Coil:

1. Factory mounted, copper tubes ½ inch OD, 0.017 inch thick tube wall mechanically expanded into 0.0045 inch thick aluminum fins. Minimum 0.03 inch galvanized steel casing.
2. Coils tested and certified in accordance with ARI 410. Leak test coil with 250 psi hydrostatic pressure.
3. Provide access door or removable panel for access upstream of coil.

- I. Fan Powered Air Volume Control Box:
 - 1. Provide forward curved direct drive fan, vibration isolation mounting, fan speed adjustable at control panel, recirculation air filter.
 - 2. Motor shall be Electronically Communicated Motor (ECM), brushless, complete with and operated by single phase integrated controller/invertor, designed for synchronous operation.
 - 3. Series flow, continuous operation. Fan controlled to turn on if heating required when primary air is off. Speed control shall accept as standard (0-20 mA) for remote adjustment from BAS.
 - 4. Provide 1-inch disposable filter on plenum air inlet.
 - 5. Units shall incorporate single point electrical connection for entire unit. All electrical components shall be enclosed in a single box with an access panel and disconnect on side of assembly.
- J. Sound Attenuator: Where scheduled, provide factory mounted discharge section, minimum 3 feet long. Casing and lining constructed same as unit construction.
- K. Control Package: Factory mount damper actuator and controller furnished by Division 23. Coordinate for direct attachment of damper actuator to shaft. Additional linkages, swivels, or levels are not acceptable. Include all required accessories to accomplish sequence of operation specified in Division 23.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated, for the specified duct pressure classification with the fewest possible joints.
- B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- C. Install fabricated fittings for changes in directions, size, and shape and for connections.
- D. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- E. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. On ductwork subject to internal condensation, pitch horizontal runs towards equipment, or source of moisture, minimum 1/8 inch per foot slope.

- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- K. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- L. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Firestopping materials and installation methods are specified in Division 07.
- M. Install ducts with hangers and braces in accordance with Division 23 "Vibration Isolation for HVAC Systems".
- N. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.2 SEAM AND JOINT SEALING

- A. Seal all duct seams and joints according to SMACNA's "HVAC Duct Construction Standards-- Metal and Flexible" for duct pressure class indicated, and SMACNA's "HVAC Leakage Test Standards" for leakage and seal class indicated.
- B. For pressure classes 2-inch wg and lower, seal transverse joints.
- C. Seal ducts before external insulation is applied. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

3.3 FLEXIBLE DUCT INSTALLATION

- A. Use only where shown on the drawings, installed in accordance with SMACNA's "HVAC Duct Construction Standards" except as specified herein.
- B. Do not install flexible duct on return or exhaust ductwork unless specifically noted on drawings.
- C. Minimum length 48 inches and maximum length of 72 inches. Install runs with minimum centerline radius of bends not less than twice duct diameter and with no more offsets than an

equivalent 90° elbow. Provide band strap hangers with saddle supports under flexible duct run to keep supports from sagging and kinking. Stretch duct enough to smooth out internal corrugations.

- D. Connect both ends to collar of rigid ductwork and air delivery device with "3M Brand" EC800 or approved equal adhesive, and secure with sheet metal screws in addition to an approved stainless steel worm gear draw band. Plastic tie straps are not permitted.

3.4 FLEXIBLE CONNECTORS INSTALLATION

- A. Provide flexible connections immediately adjacent to fans fan powered VAV boxes, , and externally isolated air handling units, to isolate and prevent transmission of vibration to ductwork and casings.
- B. Connections shall be made with a 3-inch space between duct and equipment collars, installed in line, and with 1 ½-inch excess material folded so as not to interfere with airflow through connection. Flexible connectors are not permitted as a means for correcting misalignment.
- C. Do not install flexible connectors on grease duct systems.

3.5 PVC-COATED DUCT INSTALLATION

- A. Inspect integrity of coating before, during and after installation.
- B. Repair damage to PVC coating with manufacturer's recommended materials.

3.6 UNDERSLAB DUCTS INSTALLATION

- A. Verify undamaged condition of ducts before enclosure with fill or encasement.
- B. Protect ducts from damage by equipment used in placing fill materials and concrete on or around ducts.
- C. Protect duct openings from damage and prevent entrance of foreign materials.

3.7 GREASE HOOD EXHAUST DUCTS INSTALLATION

- A. Install ducts to allow for thermal expansion through 2000 deg F temperature range.
- B. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.
- C. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1-1/2 inches from bottom; and fit with grease-tight covers of same material as duct.

- D. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.

3.8 APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- C. Butt transverse joints without gaps and coat joint with adhesive.
- D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- F. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
- G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall.
- H. Duct liner to only be installed in the following locations:
 - 1. Transfer ducts.
 - 2. Where indicated on drawings.

3.9 VOLUME DAMPERS INSTALLATION

- A. Provide volume dampers at all points on low pressure supply, return and exhaust systems where branches are taken from larger ducts as required for air balancing. Do not install volume dampers upstream of air volume control boxes in any circumstance.
- B. Install volume damper as close to main as possible, minimum 2 duct widths from branch takeoff.
- C. Install damper in acoustically lined ducts in such a manner to avoid damage to liner and to avoid erosion of duct liner.
- D. Install orange ribbon tag tied on to volume damper handle for the purpose of visibly identifying volume damper locations.

3.10 FIRE AND SMOKE DAMPER INSTALLATION

- A. Install dampers complete with required perimeter mounting angles and sleeves, in

accordance with installation instructions furnished by manufacturer, conforming to installation required of UL as a condition of listing.

- B. Install in such a manner to be accessible for testing and reset. Coordinate size and location access door. Increase duct size to accommodate minimum door size of 12 inches by 8 inches as applicable.
- C. Furnish additional fusible links, one fusible link for every five dampers installed, to Owner.
- D. Install Smoke Damper and Combination Fire Smoke Damper remote test switches at the ceiling below the damper, or where directed by the Architect.

3.11 ACCESS DOORS INSTALLATION

- A. Install duct access doors to allow inspecting, adjusting and cleaning duct mounted accessories where shown on drawings and as follows:
 - 1. Upstream and downstream of coils, filters, fans, humidifiers, control dampers, airflow measuring devices.
 - 2. Downstream of air volume control boxes.
 - 3. Adjacent to fire and fire/smoke dampers, providing adequate access to reset or reinstall fusible link.
 - 4. Adjacent to fire/smoke dampers, providing adequate access to damper actuator/motor.
 - 5. As required by NFPA requirements for duct cleaning.
- B. Where access doors are required within shaft enclosures or above inaccessible ceilings, coordinate with General Contractor and advise proper location of access panel.
- C. Identify all fire damper access doors by stenciling with bright red paint the words "FIRE DAMPER ACCESS". For spring closure dynamic curtain type fire dampers use the words "CAUTION – DYNAMIC FIRE DAMPER ACCESS".

3.12 AIR VOLUME CONTROL BOX INSTALLATION

- A. Install connecting piping to allow access to unit mounted controller and access panel.
- B. Connecting tubing and/or wiring for box installed in return air plenum ceiling to be "plenum rated" of type approved by applicable building code and local authority having jurisdiction for installation in ceiling air plenum.
- C. Install straight run, minimum of 2½ duct diameters of rigid duct connection to inlet, full size of inlet connection. Fan powered units shall be connected with flexible connections on inlet and outlet. Inlet flexible connection shall be located upstream of straight run section, not at box collar connection.
- D. Provide hanger support for air volume control boxes independent of ductwork.

3.13 AIR TERMINAL INSTALLATION

- A. After installing terminal in ceiling grid, provide 12 gauge support wire fastened independently to structure. One wire for each device weighing 10 pounds or less, two wires (opposite corners) for device weighing 11 to 55 pounds, four wires for device weighing greater than 55 pounds. Wire shall not be in tension to lift device out of grid, but with minimal slack to allow device to sit on grid.

3.14 INSTRUMENT TEST HOLES INSTALLATION

- A. Install instrument test holes where shown on the drawings and in the following locations:
 - 1. Air handling unit supply duct mains; provide multiple test ports properly spaced for traverse airflow measurement. Coordinate location with TAB Contractor.
 - 2. Return fan duct mains; provide multiple test ports properly spaced for traverse airflow measurement. Coordinate with TAB Contractor.
 - 3. Exhaust fan duct mains.
 - 4. Downstream of duct mounted coils.
 - 5. Downstream of air volume control boxes.

3.15 DUCT MOUNTED SMOKE DETECTORS INSTALLATION

- A. Install duct mounted smoke detectors furnished by Division 28. Obtain installation instructions and install in accordance with manufacturer's instructions. Mount on ductwork at locations indicated on the drawings.

3.16 SOUND ATTENUATOR INSTALLATION

- A. Install sound attenuator with rigid duct connections in accordance with manufacturer's installation instructions.
- B. Where multiple silencer units are grouped together in parallel within duct system, seal between units airtight with 3M Company EC-800 sealant.

3.17 BARRIER WRAP INSTALLATION

- A. Provide where shown or specified. Completely cover area indicated. Place absorptive backing material against surface being treated to decouple outer limp barrier material from metal.
- B. Seal all joints with minimum 2-inch overlap of limp barrier material similar to that used in construction to form continuous airtight barrier around surface being treated. Seal all joints where barrier wrap abuts building construction with acoustical sealant.
- C. Adhere with 100% coverage of adhesive. Adhere wrapping treatment to surface and also mechanically fasten by impaling absorptive backing and barrier material on stick pins or weld nail pins.
- D. Provide in the following locations:

1. Discharge of duct sound attenuator between attenuator and mechanical room wall.
2. Discharge of fan to downstream duct sound attenuator.
3. Supply and return main ducts in ceiling below rooftop unit; from unit connection including vertical duct, first elbow and first 6 feet of horizontal duct length downstream of elbow.

3.18 DUCT HANGERS AND SUPPORTS INSTALLATION

- A. Suspend and support ductwork, casings, and equipment in accordance with requirements of SMACNA Duct Construction Standards and as specified further in Sections 23 05 00 and 23 05 40, except as specified herein.
- B. No hangers shall be attached to or suspended from any type of metal deck. Attachments made beneath metal deck areas may be made by fastening to building structural members (excluding bridging and bracing) in conjunction with the use of miscellaneous auxiliary structural steel. All such steel shall conform to ASTM A36.
- C. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection. Support vertical ducts at a maximum interval of 12 feet and at each floor.
- D. Hangers must be arranged to allow the duct insulation to pass through without insulating any part of the hanger.
- E. Unless combined pipe/duct racks are shown on the drawings, provide dedicated hangers for support of ductwork.

3.19 EXTERIOR WALL LOUVER PLENUM INSTALLATION

- A. Exterior wall louvers for exhaust/intake/relief air will be provided by Division 08.
- B. Unless otherwise indicated, provide shop or field fabricated casings and plenums as specified elsewhere in this section for connection to exterior wall louvers. Where the connecting plenum is smaller than actual louver size, provide insulated blank off panel(s) for unused portions behind louver.
- C. Insulate plenum/casing as specified in 23 07 00.
- D. For suspended plenums, slope bottom of plenum down towards face of louver, minimum 1/8 inch per foot, and provide adequate flashing or weep holes at louver frame to allow entrained water to drain out through louver face.
- E. Blank off panel shall be double wall construction with internal insulation having a total R value of not less than R-13. Fabricate of aluminum of gauge required by SMACNA for size of blank off required, 18 gauge minimum. Insulation shall be moisture proof, non-wicking, mildew resistant and shall comply with ASTM E84 Flame Spread and Smoke Developed ratings.
- F. Blank-off panels shall be mounted directly behind louver blades and shall be integral with

the flashing at the bottom of the louver.

3.20 CLEANING AND PROTECTION

- A. Thoroughly clean all air stream surfaces of all equipment, devices and accessories in the air distribution systems and all air stream surfaces of ductwork, casings and plenums and maintain in a clean condition as the work progresses. Clean ductwork piece by piece, section by section as installed.
- B. Protect openings of all equipment, devices and accessories with polyethylene film or another covering to prevent entrance of moisture, dust or debris until final ductwork/casing/plenum connections are made. Similarly protect openings in ductwork, casings and plenums.
- C. After installation, either force air at high velocity through systems or use high power vacuum machines to remove accumulated dust. Protect equipment which may be harmed by dirt with filters, or bypass during cleaning. Provide adequate access into ductwork/casings/plenums for cleaning.
- D. Clean external surfaces of all of the above of foreign substances which might cause corrosive deterioration of metal or, where to be painted, might interfere with painting or cause paint deterioration.
- E. Wipe clean all air terminal units from dust entrained on face during construction.

3.21 FIELD QUALITY CONTROL

- A. Perform duct leakage testing and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports.
- B. Test all high and medium pressure ductwork during installation and before application of any exterior insulation or enclosing of ductwork.
- C. Test all low pressure ductwork during installation and before application of any exterior insulation or enclosing of ductwork. Except for ductwork located in shafts and fume hood ductwork, after successful leakage testing of at least two sections, and subject to inspection and approval of duct sealing of all untested ductwork by the TAB Contractor, testing may be omitted for low pressure ductwork.
- D. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- E. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. Do not pressurize systems above maximum design operating pressure.
- F. Conduct tests in the presence of Construction Manager. Give seven days' advance notice for testing.

- G. Maximum Allowable Leakage: Total leakage for pressure class shall not exceed permissible leakage for specified seal and leakage class.
- H. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 233000

SECTION 233319 - SOUND ATTENUATORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Duct Silencers.
- B. Acoustic Housings.

1.2 RELATED SECTIONS

- A. Section 23 05 00 – Common Work Results for HVAC Equipment.
- B. Section 23 31 13 – Metal and Non-Metal Ductwork, Casings and Plenums: Connections to silencers.
- C. Section 23 33 13 - Ductwork Accessories: Flexible duct connections.

1.3 REFERENCES

- A. AABC - National Standards for Total System Balance.
- B. AMCA 300 - Test Code for Sound Rating.
- C. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- D. AMCA 302 - Application of Sound Loudness Ratings for Non-Ducted Air Moving Devices.
- E. AMCA 303 - Application of Sound Power Level Ratings for Ducted Air Moving Devices Recommended Typical dBa Calculation.
- F. ANSI S1.1 - Acoustical Terminology (Including Mechanical Shock and Vibration).
- G. ANSI S1.8 - Preferred Reference Quantities for Acoustical Levels.

- H. ANSI S1.13 - Methods for Measurement of Sound Pressure Levels.
- I. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
- J. ARI 575 - Measuring Machinery Sound Within Equipment Rooms.
- K. ASA 16 (ANSI S1.36) - Survey Methods for Determination of Sound Power Levels of Noise Sources.
- L. ASA 47 (ANSI S1.4) - Specification for Sound Level Meters.
- M. ASA 49 (ANSI S12.1) - Preparation of Standard Procedures to Determine the Noise Emission from Sources.
- N. ASHRAE 68 - Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
- O. ASHRAE Handbook - Systems Volume, Chapter "Sound and Vibration Control".
- P. ASTM E90 - Method for Laboratory Measurement of Airborne Sound Transmission of Building Partitions.
- Q. ASTM E477 - Method of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance.
- R. ASTM E596 - Method for Laboratory Measurement of the Noise Reduction of Sound Isolating Enclosures.
- S. NEBB - Procedural Standards for Measuring Sound and Vibration.
- T. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.4 DEFINITIONS

- A. Submittals and Report: Conform to ANSI S1.1.

1.5 PERFORMANCE REQUIREMENTS

- A. Maintain sound level as specified on schedules and per sound consultant data requirements.

1.6 SUBMITTALS

- A. Submit under provisions of Section 23 05 00.
- B. Shop Drawings: Indicate assembly, materials, thicknesses, dimensional data, pressure losses, acoustical performance, layout, and connection details.
- C. Product Data: Provide catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance.
- D. Samples: Submit two cross-talk silencers [x] inch in size.
- E. Design Data: Provide engineering calculations, referenced to specifications.
- F. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers. Acoustic housings meet or exceed specified sound transmission loss values.
- G. Manufacturer's Installation Instructions: Indicate installation requirements which maintain integrity of sound isolation.
- H. Manufacturer's Field Reports: Indicate installation is complete and in accordance with instructions.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 23 05 00.
- B. Record actual locations of acoustic housings.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with AMCA 300, ANSI S1.13, ARI 575, ASA 16 (ANSI S1.36)] standards and recommendations of ASHRAE 68.
- B. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.
- B. Design application of acoustic housings under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Minnesota.

1.10 REGULATORY REQUIREMENTS

- A. Conform to applicable code for sound levels at property line.
- B. Fill material to conform with NFPA Standard 255, ASTM E-84, or UL No. 723.

PART 2 - PRODUCTS

2.1 DUCT SILENCERS

- A. Manufacturers:
 - 1. Industrial Acoustics Co.
 - 2. Vibro Acoustics.
 - 3. Price.
 - 4. Substitutions: Refer to Section 23 05 00.

- B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Configuration: Rectangular, round, or elbow duct silencer with performance characteristics as indicated.
- D. Materials:
 - 1. Outer Casing: Minimum 22 gage thick galvanized steel stiffened as required, with mastic filled lock formed or welded seams, 2-inch long, 11 gage slip joints on both ends.
 - 2. Inner Casing and Splitters: Minimum 24 gage thick perforated galvanized steel.
 - 3. Fill Material: Provide with the following as indicated:
 - a. Inert and vermin-proof fibrous material, packed under not less than 5 percent compression, mylar lined resistant to erosion (1 mil minimum).
- E. Fire Performance: Adhesives, sealants, and packing materials shall have fire ratings not exceeding 25 for flame spread index and 50 for smoke developed index when tested according to ASTM E84.
- F. Fabricate to form rigid unit that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Unit shall not experience air leakage up to differential pressure of 6 inch wg from inside to outside for ductwork outside of mechanical rooms and 10 inch wg for silencers installed inside mechanical rooms. Seams and joints lock formed and sealed or continuously welded. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
- G. Source Quality Control: Factory test according to ASTM E477. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000 fpm face velocity. Test methods shall eliminate effects due to test room conditions. Published performance data shall include all octave bands (63 Hz to 8000 Hz).
- H. Performance: The dynamic insertion loss in decibels (dB) shall not be less than that scheduled on drawings throughout all octave bands.

2.2 ACOUSTIC HOUSINGS (Generator Room)

- A. Manufacturers:
 - 1. Vibro Acoustic.
 - 2. Aerosonics, Inc.
 - 3. Industrial Acoustics Co.
 - 4. Price
 - 5. Substitutions: Refer to Section 23 05 00.
- B. Description: Custom transitional silencer including access doors and windows, and dampers, nominal 4 inches thick, with filled outer and inner casing. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Fire Performance: Adhesives, sealants, and packing materials shall have fire ratings not exceeding 25 for flame spread index and 50 for smoke developed index when tested according to ASTM E84.

Outer Casing: Minimum 18 gage thick galvanized steel stiffened as required, with mastic filled lock formed or welded seams for internal flange butt covering strip butt, overlapping lip, tongue and groove joining. Mount wall panels on minimum 4 inch high concrete curbs with continuous bottom plate (stud). Provide anchors every 24" to secure to curb.

- 1. Inner Casing and Splitters: Minimum 22 gage thick perforated or solid galvanized steel.
 - 2. Fill: Glass fiber or mineral wool of minimum 6 lb/cu ft density.
 - 3. Fill Liner: 1 mil mylar film.
 - 4. Window: 12 x 12 double glazed with 1/4 inch safety glass (Indoors).
 - 5. 24" x 60" access doors with hinges and latch handle. 6"x6" window.
- D. Accessories: See drawings.
- E. Rating: Refer to schedule on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions. Provide rigid duct connections silencers installed in ductwork.
- B. Support duct silencers rigidly to curbs and ceiling and adjacent wall panels.
- C. Where multiple silencer units are grouped together in parallel within duct system, seal between units airtight with 3M Company EC-800 sealant.
- D. Acoustical Panels shall be set on 6" wide continuous concrete curbs. Refer to architectural drawings. Secure panels to curb and adjacent wall and roof structures. Provide kickers, or other reinforcing as required for generator start-up static pressure of up to 10 inches.
- E. Provide 24" wide x 60" high hinged access doors to all portions of acoustical panels for service. Locate panels 12" above the floor line. Provide 12x12 window in door. Coordinate with division 26 for lighting in each section.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide services of AABC or NEBB testing agency to take noise measurement. Use meters meeting requirements of ASA 47 (ANSI S1.4).
- B. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations, as directed.
- C. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements.
- D. Submit complete report of test results including sound curves.

END OF SECTION 23 33 19

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Louver face diffusers.
 - 3. Fixed face registers and grilles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

- A. Rectangular and Square Ceiling Diffusers:
 - 1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:

- a. METALAIRE, Inc.
 - b. Nailor Industries Inc.
 - c. Price Industries.
 - d. Titus.
 - e. or Equal
 2. Material: Steel.
 3. Finish: Baked enamel, white.
 4. Face Size: 24 by 24 inches.
 5. Mounting: T-bar.
 6. Pattern: Fixed, or Perforated
 7. Accessories:
 - a. Plaster ring.
 - b. Sectorizing baffles.
- B. Louver Face Diffuser:
1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. METALAIRE, Inc.
 - b. Nailor Industries Inc.
 - c. Price Industries.
 - d. Titus.
 - e. or Equal
 2. Devices shall be specifically designed for variable-air-volume flows.
 3. Material: Steel
 4. Finish: Baked enamel, white.
 5. Mounting: Surface.
 6. Pattern: Two-way core style.
 7. Accessories:

- a. Square to round neck adaptor.
- b. Adjustable pattern vanes.
- c. Throw reducing vanes.
- d. Equalizing grid.
- e. Plaster ring.
- f. Sectorizing baffles.

2.2 REGISTERS AND GRILLES

A. Fixed Face Register:

1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. Nailor Industries Inc.
 - b. Price Industries.
 - c. Titus.
 - d. Or Equal
2. Material: Steel
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Removable.
6. Frame: 1-1/4 inches wide.
7. Mounting: Lay in.

B. Fixed Face Grille:

1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. Nailor Industries Inc.
 - b. Price Industries.
 - c. Titus.
 - d. Or Equal
2. Material: Steel
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.

5. Core Construction: Removable.
6. Frame: 1-1/4 inches wide.
7. Mounting: Lay in.

C. Linear Bar Grille:

1. Manufacturers: Subject to compliance with requirements. Provide product indicated on drawings or one of the following:
 - a. Nailor Industries Inc.
 - b. Price Industries.
 - c. Titus.
 - d. Or Equal
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Frame: 1-1/4 inches wide.
6. Mounting: Lay in.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling

panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of roof-mounting intake and relief ventilators:
 - 1. Louver penthouses.
 - 2. Goosenecks.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Intake and relief ventilators shall be capable of withstanding the effects of gravity loads, wind loads, and thermal movements without permanent deformation of components, noise or metal fatigue, or permanent damage to fasteners and anchors.
- B. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1-2004.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For intake and relief ventilators. Include plans, elevations, sections, details, and ventilator attachments to curbs and curb attachments to roof structure.
- C. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which roof curbs and ventilators will be attached.
 - 2. Sizes and locations of roof openings.
- D. Samples for Verification: For each type of exposed finish required for intake and relief ventilators.
- E. Welding certificates.
- F. Hurricane-Impact Ratings: Provide submittal of Miami-Dade County Hurricane Impact Testing/NOA Certification.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain ventilators through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of intake and relief ventilators and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2, "Structural Welding Code--Aluminum."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.6 COORDINATION

- A. Coordinate installation of roof curbs and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 or 6 finish.

2.3 FABRICATION, GENERAL

- A. Factory or shop fabricate intake and relief ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.4 HURRICANE IMPACT RATED LOUVER PENTHOUSES

- A. Manufacturers:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Ruskin
 - 3. Greenheck
- B. Ruskin Greenheck Construction: All-welded assembly with 6 inch deep louvers, mitered corners, and galvanized steel sheet roof.
- C. Frame and Blade Material and Nominal Thickness: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inch for blades.
- D. Frame and Blade Material and Nominal Thickness: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inch for frames and 0.064 inch for blades.
- E. Frame and Blade Material and Nominal Thickness: Stainless-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.062 inch with grain running parallel to length of blades and frame members. Louver blades shall be capable of withstanding a wind driven rain.
 - 1. Blade spacing: 3".
 - 2. Blade angle: 45°
 - 3. Air Performance: Not more than 0.10-inch wg static pressure drop at 800-fpm free-area velocity
 - 4. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
 - 5. Exterior Corners: Prefabricated corner units with mitered blades with concealed close-fitting splices and with fully recessed mullions at corners.

2.5 ROOF HOODS – HURRICANE IMPACT RATED

- A. Manufacturers:
 - 1. Ruskin.

2. Greenheck.
 - B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 5-6 and 5-7.
 - C. Materials: Galvanized-steel sheet, minimum 0.064-inch- thick base and 0.040-inch- thick hood; suitably reinforced.
 - D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base, and to allow 36" minimum above roof to bottom of louver.
 1. Configuration: Built-in raised cant and mounting flange.
 2. Overall Height: 24 inches.
 - E. Bird Screening: Stainless-steel, 1/2-inch- square mesh, 0.047-inch wire.
 - F. Galvanized Steel Sheet Finish:
 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
 2. Factory Priming for Field Painted Finish: Where field painting after installation is indicated, apply an air dried primer immediately after cleaning and pretreating.

2.6 GOOSENECKS

- A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 5-5; with a minimum of 0.052-inch- thick, galvanized-steel sheet.
- B. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
 1. Configuration: Built-in raised cant and mounting flange.
 2. Overall Height: 36 inches.
- C. Bird Screening: Aluminum, 1/2 inch square mesh, 0.063 inch wire.
- D. Galvanized-Steel Sheet Finish:
 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
 2. Factory Priming for Field Painted Finish: Where field painting after installation is indicated, apply an air dried primer immediately after cleaning and pretreating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install intake and relief ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Secure intake and relief ventilators to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- C. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.
- D. Install intake and relief ventilators with clearances for service and maintenance.
- E. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 Section "Joint Sealants" for sealants applied during installation.
- G. Label intake and relief ventilators according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- H. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- I. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

END OF DOCUMENT 233723

SECTION 234100 - AIR FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Particulate Air filter(s) mounted in air handling unit(s) and ductwork systems.

B. Air filter draft gauge.

C. UVC Emitter Ultraviolet Disinfection

D. Equipment Furnished by This Section for Installation Under Other Sections

1. Filters factory installed in air handling units.

2. Furnish filters located in ductwork, to Contractor for installation by that section.

3. Furnish filters located in built-up air handling units, to Contractor for installation by that section.

E. Related Sections:

1. Terminal Filter Diffusers are specified in Section 23 30 00.

1.3 DEFINITIONS

A. MERV: Minimum Efficiency Reporting Value.

B. HEPA: High-efficiency Particulate Air.

C. ULPA: Ultra-low Penetration Air.

D. DOP: Dioctyl phthalate or bis – (2-ethylhexyl) phthalate.

1.4 REFERENCES

A. ASHRAE-52.2 Methods of Testing Air-cleaning Devices used in General Ventilation for Removing Particulate Matter

B. IEST Institute of Environmental Sciences and Technology

C. NFPA Applicable standards

D. UL Applicable standards

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data including flow capacity, initial and final pressure drop at rated airflow, efficiency and test methods, dust holding capacity, fire classification and installation instructions.
- B. Shop Drawings: Include plan, elevations, sections and details to illustrate component assemblies and attachments. Show filter holding frame assembly details dimensions and materials. Identify means for filter removal and change out.
- C. Source Quality Test Reports: Submit factory certified test reports for each HEPA filter.
- D. Submit design documentation on UVC emitters indicating inputs of cooling coil size, distance between UVC emitters and coil surface, quantity of fixtures, and fixture row spacing. Outputs shall include achieved average, minimum, and maximum surface irradiances including drain pan. Submit graphic output of design surface irradiance on coil face.

1.6 QUALITY ASSURANCE

- A. For MERV 13 and higher, the manufacturer shall submit ASHRAE 52.2 test reports for each grade of filter being offered. The report shall be prepared by an independent laboratory using test equipment, method and duct section as specified by ASHRAE Standard 52.2. The filter shall be required to meet the same MERV-A value when tested per Appendix J of ASHRAE Standard 52.2-2007. Filters with a MERV-A value lower than the MERV value are not acceptable.
- B. All filter holding frames and filter media packs shall be equipped with full perimeter gasketing to prevent air bypass. Completely seal full perimeter of holding frame and inside surface of air handling unit or duct. Provide safing as required.
- C. Provide additional support bracing and/or reinforce filter holding frames to be capable of withstanding manufacturer's maximum recommended filter pressure drop without deformation of holding frame assembly.
- D. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- E. Comply with NFPA 90A and NFPA 90B.
- F. Electrical Components, Devices, and Accessories: Comply with NFPA 70 for installing electrical components. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- G. UL Compliance: Comply with UL Standard 1995 as applicable to usage of UVC Emitters in HVAC equipment.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store and handle filters and accessories in accordance with manufacturer's recommendations.
- B. Filters shall be stored in original containers until all construction on site is completed. Storage shall be in a dry location, away from direct construction activity. Do not store any equipment or parts on top of

filter containers that may dent or damage filters. Do not install any filters that have been damaged or become wet. Replace in kind.

PART 2 - PRODUCTS

2.1 PARTICULATE AIR FILTERS

A. Acceptable Manufacturers:

1. Camfil-Farr Co.
2. American Air Filter Co., Inc.
3. Flanders
4. Purolator
5. Viledon

B. General: Select filter media that is UL listed, Class I or Class II, as approved by local authorities. Filter shall have a Minimum Efficiency Reporting Value (MERV) in accordance with ASHRAE 52.2 and shall have minimum efficiency values listed for specified particle sizes.

C. Panel Prefilter

1. General: The filter shall be classified as UL Class 1.
2. Media: Filter media shall be cotton/fibrous blend laminated to an all-glass mesh backing and formed into uniform radial pleats, depth as scheduled. A welded wire grid, spot-welded on one inch centers and treated for corrosion resistance, bonded to the downstream side of the media to maintain the radial pleat.
3. Frame: Enclosing frame of nonflammable board bonded to the media to prevent air bypass, and include integral diagonal support members on the air entering and exiting side to maintain uniform pleat spacing.
4. Performance: The filter shall be MERV 8 using mechanical particle capture and shall have minimum efficiency of 70% on 3.0 to 10.0 micron particles when evaluated under guidelines of ASHRAE 52.2. Initial resistance to airflow shall not exceed 0.31 inches at 500 ft/min face velocity.
5. Arrangement: Flat when used in conjunction with higher efficiency filter. Otherwise angle filter section. For angle filter section, limit filter velocity, based on gross area, to less than 300 ft./min. Provide access doors both sides.

D. High Efficiency Cartridge Filter

1. Two stage filter assembly consisting of panel prefilters as specified hereinbefore and cartridge filters assembled in a single housing, as scheduled. Filter rated as UL Class 2.
2. Cartridge Filter Media: 12 inch deep filter media shall be of microfine glass laminated to a reinforcing backing to form a uniform lofted media blanket. The media blanket shall be formed into uniform tapered radial pleats and supported by a nonmetallic stiffened media backing. The media shall be mechanically and chemically bonded to the inside periphery of the enclosing frame to prevent air bypass. The nonmetallic enclosing frame shall be constructed of multiple laminate layers that shall be resistant to high-humidity and maintain a rigid and durable enclosure. Contour stabilizers of polymeric methylene disocyanate construction shall provide media support and pleat stabilization. There shall be a minimum of four contour stabilizers each on the air entering and air exiting sides. Face grilles, constructed of medium-impact plastic that does not produce harmful phenols or contaminants, shall be permanently secured to the air entering and air exiting sides to protect the media pack and assist in structural integrity.
3. Cartridge Filter Holding Frame: 16 gauge galvanized steel, with sealing grooves and gaskets, locking clips, and provision for front mounted prefilter and front or rear removal of filter media as required. For stacked filter frames, provide reinforced frame capable of withstanding the specified static pressure.

4. Assembly Housing: Prefilter tracks, filter slide channels and continuously gasketed access doors at each end of unit. Construction to include adequate seals to prevent passage of unfiltered air.
5. Cartridge Filter Efficiency: Filter shall be MERV 13 and shall have minimum efficiency values of 90% on 1.0 to 3.0 micron particles and 90% on 3.0 to 10.0 micron particles when evaluated under guidelines of ASHRAE 52.2. Maximum initial resistance at 500 ft/min face velocity of 0.50 inches water gauge. Filter shall be MERV 14 and shall have minimum efficiency values of 75% on 0.3 to 1.0 micron particles and 90% on 3.0 to 10.0 micron particles when evaluated under guidelines of ASHRAE 52.2. Maximum initial resistance at 500 ft/min face velocity of 0.68 inches water gauge as scheduled.

E. High Efficiency Particulate (HEPA) Filter

1. Filters shall be absolute grade HEPA filters consisting of pleated media packs assembled in a V-bank configuration, polyurethane sealant, anodized aluminum enclosure and seamless sealing gasket
2. HEPA Filter Construction: Filter media shall be micro fiber glass formed into minipleat pleat-in-pleat V-bank design. The media packs shall be potted into the enclosing frame with fire retardant polyurethane sealant. An enclosing frame of galvanized steel 304 stainless steel shall form a rugged and durable enclosure. A seamless sealing gasket shall be included on the downstream side of the filter to form a positive seal upon installation. Filter must be listed as UL 586 and UL 900 Class 2 per Underwriters Laboratories. Initial resistance target shall not exceed 0.90 inch w.g. at 600 FPM approach velocity.
3. HEPA Filter Holding Frame: 14 gauge galvanized steel with sealing grooves and gaskets, locking clips, and provision for front mounted prefilter and front or rear removal of filter media as required.
4. Assembly Housing: Prefilter tracks, filter slide channels and continuously gasketed access doors at each end of unit. Construction to include adequate seals to prevent passage of unfiltered air.
5. HEPA Filter Efficiency: Each filter shall be individually tested and certified to a minimum efficiency at 0.3 micron of 99.99% using a near monodispersed thermally generated challenge when evaluated according to the current edition of IEST-RP-CC-001. Each filter shall be individually tested, certified and labeled as to tested performance.
6. DOP (Diocetyl Phthalate) shall not be used in the testing of HEPA filters.

F. Filter Unit for Fume Hood Exhaust Hospital Isolation Exhaust:

1. General

- a. Housing shall be side-access bag-in/bag-out, gasket seal housing and equipped with inlet and outlet bubble tight isolation damper(s) with manual operators. The housing shall be adequately reinforced to withstand a negative or positive pressure of 15 inch water gauge. Housing design and filter arrangement shall allow air to enter and exit housing without changing direction. The housing shall accommodate standard size filters that do not require any special attachments or devices to function properly in the housing.
- b. All products furnished under this section shall be manufactured to the critical safety requirements of ASME N509, ASME N510, ASME AG-1, as well as the full scope Quality Assurance requirements of ASME NQA-1 and DOE 414-1A. Equipment submittals require a copy of latest federal audit confirming compliance.
- c. Sizes shall be noted on enclosed drawings or other supporting materials.
- d. Housing shall be weather- and watertight suitable for installation outdoors.

2. Construction

- a. Housing shall be constructed of 14 gauge and 11 gauge T-304 stainless steel metal. All pressure retaining joints and seams shall be continuously welded with no porosities.

Joints and seams requiring intermittent welds, such as reinforcement members, shall be intermittently welded. Housing shall be free of burrs and sharp edges. All weld joints and seams that are a portion of any gasket setting surface, (duct connection flanges and filter sealing surfaces), shall be ground smooth and flush with adjacent base metals. All welded joints and seams shall be wire brushed to remove heat discoloration. The housing shall be reinforced to withstand a positive or negative pressure of 15 inch w.g. The upstream and downstream ductwork connections shall have 1-1/2 inch outward-turned flanges

- b. The housing shall have a bagging ring around each filter access port that is sealed by a gasketed filter access door. The filter access door gasket shall be silicone and shall be replaceable, if necessary. The bagging ring shall have two (2) continuous formed raised ridges to secure the PVC change-out bag. The bagging ring shall be hemmed on the outer edge to prevent the change-out bag from tearing.
- c. Ancillary hardware including filter clamping mechanism, door handles, door studs and labels shall be 300 series stainless steel. The threaded pivot blocks in the filter clamping mechanisms shall be of brass construction. Filter access door knobs shall be cast aluminum and designed to prevent galling of threads.
- d. A filter clamping mechanism shall be operated by means of a standard wrench from outside the housing. The clamping mechanism shall include two pressure channel assemblies with eight springs per filter and exert a minimum filter sealing force of 1,400 pounds per full size filter, 1050 pounds per half size filter, and 700 pounds per quarter size filter. The force shall be applied as an even, uniform load along at least 80% of the top and bottom of each filter outer frame. The filter clamping mechanism adjustment penetration through the housing wall shall be sealed airtight.
- e. One PVC change-out bag shall be furnished with each filter access port. Change-out bags shall be 8-mil. thick with a yellow translucent, nonsticking, matte finish. It shall include a 1/4 inch diameter elastic shock cord hemmed into the opening of the bag so when stretched around the housing bagging ring flange, a secure fit is created. The bag shall include three (3) integral glove ports to assist in filter change-out. One (1) nylon security strap shall be included per filter access port to prevent the bag from sliding off the bagging flange during the change-out process. Design of components shall be such that all change-out operations shall be within the bag so there is a barrier between the worker and the filter at all times. Filter housing, filter and containment bags shall be manufactured by the same company.

3. Performance

- a. All welding procedures, welders, and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. All production welds shall be visually inspected by qualified personnel per Section 5 & 6 of AWS D9.1-1990, Specification for Welding of Sheet Metal.
- b. The filter housing shall be factory tested for filter fit, flatness of filter sealing surface and operation of filter clamping mechanism. The filter sealing surface and the complete assembly pressure boundary shall be leak tested by the pressure decay method as defined in ASME N510-1995 Reaffirmed., Testing of Nuclear Air Cleaning Systems, paragraphs 6 and 7. The filter sealing surface shall be tested at +10 inch water gauge and have a maximum leak rate of 0.0005 cfm per cubic foot of housing volume. The overall system pressure boundary shall be leak tested at +15 inch water gauge and have a maximum leak rate of 0.0005 cfm per cubic foot of housing volume.
- c. Filter bags shall be capable of continuous operating to temperature extremes of 0° F. to 150° F.

- d. Multiwide housing shall be equipped with a filter removal rod to pull the filters to the change-out position. The removal rod shall operate from the inside of the filter change out bag.

4. Filter Media:

- a. HEPA filters shall be extended media separator type filters of sizes, capacities and construction options shall be as scheduled on the drawings. Filters shall be UL 900 Class 1 listed.
- b. The filter pack shall be constructed by pleating a continuous sheet of non-woven water-resistant fiberglass media around hemmed-edge corrugated aluminum separators. The filter pack shall be sealed into a 16 ga. 304 stainless steel frame with a fire retardant solid urethane sealant. Filter shall be sealed in the mounting device by means of a 40 durometer closed-cell neoprene gasket.
- c. Initial resistance shall not exceed 1.4 inch w.g. at 500 fpm approach velocity. HEPA filters shall have a minimum efficiency of 99.99% on 0.30 micrometer particles when tested at rated capacity on a Q-107 Penetrometer. Each filter shall be challenged with an approved nearly monodispersed oil aerosol of 0.30 micrometer size. Measure the upstream and downstream concentration of these particles with a light scattering photometer, determine the penetration and calculate the efficiency. In addition, all HEPA filters shall undergo a factory scan testing in accordance with Section 6.2 of IEST-RP-CC034.1. The scan test shall consist of challenging the filter with a high concentration of an approved oil aerosol or polystyrene latex spheres. Utilizing a photometer or particle counter, the media pack and the pack-to-frame seal shall be scanned to insure that there are no leaks greater than .01% of the upstream concentration at 100 fpm face velocity.

2.2 AIR FILTER DRAFT GAUGE

A. Acceptable Manufacturers:

1. Dwyer Instruments, Inc.
2. American Air filter, Co., Inc.
3. Ellison Instrument Division

B. Provide at each air filter section with taps upstream and downstream of filter located in an easily visible location.

C. Indoor Installation: Magnehelic type, shutoff cock to atmosphere for checking zero setting, shutoff cocks in lines to points where draft is measured, white background scale with heavy black divisions and figures, not less than 4-1/2 inches in diameter. Outdoor Installation: Inclined tube differential type, vent valves for zeroing, shutoff cocks in lines to points where draft is measured, solid acrylic plastic construction, built-in level vial, adjustable mirror-polished scale.

D. Graduations as follows:

<u>Differential</u>	<u>Maximum Graduations</u>	<u>Equivalent Dwyer Model No.</u>
1 inch	.02 inch	2001 and 250.5-AF
2 inches	.05 inch	2002 and 252-AF
3 inches	.10 inch	2003 and 209-AF
4 inches	.10 inch	2004 and 350-AF, vertical scale

2.3 CARBON FILTERS

A. Acceptable Manufacturers:

1. Camfil – Farr
2. Purafil
3. American Air Filters
4. Purolator
5. Flanders

B. Cylinder Type Carbon Filter

1. General: Two stage assembly consisting of carbon filter unit casing housing multiple cylinder arrangement with upstream 2 inch MERV 8 panel filter.
2. Molecular media cylinders to be constructed of high impact ABS Plastic and shall be enclosed with a plastic end cap. The cap shall be disposable and be replaced during every molecular media replacement interval.
3. The air inlet to the cylinder shall be conical in shape to facilitate uniform airflow across the molecular media
4. Each cylinder shall include a minimum of 4.2 slots per square inch of cylinder surface area. There shall be a minimum of 200 slots of per 2 inches of cylinder length
5. Each cylinder shall include a mounting assembly with three integral stainless steel bayonet stubs for mounting to the mounting flange.
6. Each Cylinder shall include 1.5 Pounds of media per 6 inches of cylinder length.
7. Maximum pressure drop of 0.5 Inches at 500 FPM.
8. Molecular Media type and cylinder size as scheduled.
9. Provide 24 inch x 24 inch cylinder holding frame

C. Cartridge Type Carbon Filter

1. Compact 12" deep absorber type with combination sorbent/particulate removal media, impact-resistant plastic end caps, plastic vertical support channels, and a nominal 1" header for front or side-access applications.
2. Filter sizes shall be as scheduled.
3. Filter media shall be specifically manufactured for the removal of molecular and particulate contaminants. Sorbent shall be broad spectrum grade of carbon incorporating Rapid Adsorption Dynamics (RAD) designed for the removal of a wide range of odors and VOC's.
4. Total media area shall be at least 0.038 square feet per rated cfm of filter.
5. The media shall be formed into uniform pleats using hot-melt separators, assembled into multi-media packs and bonded into a high impact resistant plastic frame to prevent air bypass.
6. Particulate and Initial Resistance shall not exceed 0.37 inches w.g. (+/-10%) at 500 feet per minute velocity.
7. The filter shall have a Minimum Efficiency Reporting Value of MERV 13 when evaluated in accordance with ASHRAE Standard 52.2.

D. Module Type Carbon Filter

1. Module shall be constructed of high impact plastic with tongue and groove flat frame design.
2. Modules to have aerodynamic airfoil screens to provide low pressure drop.
3. Each module to be placed on a media settling table during construction to ensure a packed media bed and prevent bypass of contaminated air.
4. Module size and media type as scheduled

E. Pleated Carbon Impregnated Filters

1. Air filters shall be medium efficiency ASHRAE pleated panels consisting of a dual layer MERV 8 synthetic media and embedded activated carbon media, media support grid, and enclosing frame.
2. Filter size shall be as scheduled
3. An enclosing frame, of high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media to prevent air bypass and include integral diagonal support members on the air entering and air existing side to maintain uniform pleat spacing in varying airflows.
4. Each filter shall be individually sealed within poly-film to extend storage life of activated carbon.
5. Initial resistance to airflow shall not exceed 0.50" w.g. at 500fpm
6. The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated in accordance with ASHRAE Standard 52.2.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all equipment as indicated and as recommended by manufacturer.

3.2 ALL EQUIPMENT WITH FILTERS

- A. If equipment is required to operate during construction, provide temporary filters for use during construction of Minimum Efficiency Reporting Value (MERV) of 8 when evaluated under guidelines of ASHRAE 52.2. Do not operate unit until filters (temporary or permanent) are in place. Replace all temporary filters used during construction with specified filters before turning equipment over to Owner. Provide new filters as specified for air balancing work. Provide Owner with one additional spare set of all filters.

3.3 CERTIFICATION TESTING FOR HEPA FILTERS

- A. Provide the owner labeled factory certification report for all HEPA filters. Contractor to provide an independent field integrity testing certification in accordance with IEST Recommended Practices for all HEPA filters.

3.4 INSTALLATION OF PARTICULATE AIR FILTERS

- A. Install filter frames according to manufacturer's written instructions.
- B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- C. Install filters in position to prevent passage of unfiltered air.
- D. Install filter draft gage for each filter bank.
- E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

F. Coordinate filter installations with duct and air-handling unit installations.

END OF SECTION 234100

SECTION 237316 - CUSTOM CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

1. Fan, Drive, and Motor Section.
2. Coil Section.
3. Air Filtration Section.
4. Dampers.
5. Humidifiers.
6. Air Blender.

1.2 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 REFERENCE STANDARDS

- A. AMCA 204 - Balance Quality and Vibration Levels for Fans.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- C. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans.
- D. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- E. AMCA 500 - Laboratory Methods of Testing Louvers for Rating.
- F. ARI 410 - Performance Rating of Forced-circulation Air-cooling and Air-heating Coils.
- G. ARI 430 - Performance Rating of Central Station Air-handling Unit Supply Fans.
- H. ASCE/SEI 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- I. ASHRAE 33 - Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils.
- J. ASHRAE Std 52.1 - Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter.
- K. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- L. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality.

- M. ASME N510 - Testing of Nuclear Air Treatment Systems.
- N. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- O. IESNA 90.1 - Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings.
- P. NEMA MG 1 - Motors and Generators.
- Q. NFPA 70 - National Electrical Code.
- R. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.5 SUBMITTALS

A. Action Submittals

1. Product Data: For each air-handling unit indicated.
 - a. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - a. Fans:
 - 1) Certified fan-performance curves with system operating conditions indicated.
 - 2) Certified fan-sound power ratings.
 - 3) Fan construction and accessories.
 - 4) Motor ratings, electrical characteristics, and motor accessories.
 - b. Certified coil-performance ratings with system operating conditions indicated.
 - c. Dampers, including housings, linkages, and operators.
 - d. Filters with performance characteristics.
 - e. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.
 - f. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - g. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - h. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
3. Source quality-control reports.
4. Field quality-control reports.
5. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

B. Informational Submittals

C. Closeout Submittals

D. Operation and Maintenance Materials

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- a. Filters: One set(s) for each air-handling unit.
- b. Gaskets: One set(s) for each access door.
- c. Fan Belts: One set(s) for each air-handling unit fan.

E. Record Documents

1.6 WARRANTIES

- A. Provide an additional 12 month limited parts only warranty in addition to base project warranty requirements.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE Std 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.8 PRE-INSTALLATION TESTING

- A. The manufacturer shall perform an air performance test on one selected unit in accordance to ANSI/AMCA Standard 210-16, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance rating. Air handling unit air performance data shall be submitted for review by the Owner's representative.
- B. The manufacturer shall perform a sound test on one selected AHU in accordance with AMCA Standard 300-14, Reverberant Room Method for sound testing of fans, and ANSI/AMCA Standard 210-16. The mechanical engineer shall select the test AHU after review of the submittal.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle under the supervision of the owner and in accordance with the manufacturer's Operation & Maintenance manuals
- B. Equipment shall be covered by factory applied shrink wrap material to protect it from accumulating dirt or moisture during transit. The covering shall include a minimum of one zippered opening to allow field access for preventing interior condensation during storage.)

1.11 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents
 - 1. Filters: One set(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.
 - 3. Fan Belts: One set(s) for each air-handling unit fan.

1.12 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of $L/200$ where "L" is the unsupported span length within completed casings.
- C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

PART 2 PRODUCTS

2.1 GENERAL

- A. MANUFACTURERS
 - 1. Buffalo Air Handling.
 - 2. Johnson Controls Custom.
 - 3. TMI Climate Solutions.
 - 4. Trane Custom
- B. SOURCE QUALITY CONTROL
 - 1. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-

certified sound ratings seal.

2. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210 , "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
3. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.
4. Steam Coils: Factory tested to 300 psig and to 200 psig under water according to ARI 410 and ASHRAE 33.
5. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.

C. UNIT CASINGS

1. General Fabrication Requirements for Casings:
 - a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
 - b. Casing Joints: Sheet metal screws or pop rivets.
 - c. Sealing: Seal all joints with water-resistant sealant.
 - d. Factory Finish for Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - e. Factory Finish for Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
 - f. Casing Coating: Thermoplastic vinyl
 - g. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
2. Casing Insulation and Adhesive:
 - a. Materials: ASTM C1071, Type I.
 - b. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
 - 1) Liner Adhesive: Comply with {RS#818}, Type I.
 - 2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - 3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
 - c. Location and Application: Encased between outside and inside casing.
3. Inspection and Access Panels and Access Doors:
 - a. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Inspection and Access Panels:
 - 1) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - 2) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 3) Size: Large enough to allow inspection and maintenance of air-handling unit's

- internal components.
- c. Access Doors:
 - 1) Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - 2) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 3) Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
 - 4) Size: At least 18 inches (450 mm) wide by full height of unit casing up to a maximum height of 60 inches (1500 mm).
- d. Locations and Applications:
 - 1) Fan Section: Inspection and access panels
 - 2) Access Section: Doors.
 - 3) Coil Section: Inspection and access panel.
 - 4) Damper Section: Inspection and access panels.
 - 5) Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
 - 6) Mixing Section: Doors.
 - 7) Humidifier Section: Doors.
- e. Service Light: Vapor proof fixture with 100W equivalent medium base compact fluorescent lamp with switched junction box located outside adjacent to door.
 - 1) Locations: Each section accessed with door
- 4. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE Std 62.1.
 - 2) Depth: A minimum of 2 inch deep.
 - b. Formed sections.
 - c. Single-wall, galvanized steel sheet.
 - d. Double-wall, galvanized steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - e. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: NPS 1 (DN 25).
 - f. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - g. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- 5. Service Platform: Steel wide running entire length of unit and located on service access side, with angle side rails, 4 inch kick plates, and expanded metal floor. Provide platform with a fixed ladder that extends from the top of the side rail to the floor.

6. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
 - a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 20 Section 200548 "Vibration and Seismic Controls" when air-handling unit frame is anchored to building structure.

D. FAN, DRIVE, AND MOTOR SECTION

1. Fans and Motors: Fan Array System: The fan array system shall consist of multiple, direct driven, arrangement 4 plenum fans AMCA certified for the duty specified, (Class I, II, or III).
 - a. Provide fans with redundant variable speed drives. Variable speed drives shall meet specification section 230934 Variable Frequency Motor Controllers for HVAC.
 - b. All fans shall be selected to deliver the specified airflow quantity at the specified operating total static pressure and specified motor speed.
 - c. The fans shall be selected to operate at a system total static pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed.
 - d. Each fan/motor assembly shall include a minimum 12 airfoil blade aluminum wheel, an 11 gauge, galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge G90 galvanized steel motor support plate and structure.
 - e. The fan air inlet cone, and motor support structure shall be powder coated for corrosion resistance.
 - f. All motors are to be standard T-frame pedestal mounted type, (TEFC), selected at the specified operating voltage, rpm, and efficiency as specified or as scheduled elsewhere.
 - g. All motors shall include isolated bearings or shaft grounding.
 - h. All motors shall be premium efficiency, IEEE inverter ready rated with appropriate winding insulation to meet NEMA MG 1, part 1 requirements.
 - i. The tip speed for each fan shall not exceed 6000 fpm. The fan motor shall operate at a maximum of 80 Hz to achieve scheduled air flow.
 - j. Each fan/motor assembly shall be provided with acoustical silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the air handling unit when compared to the same fan array unit without the silencers.
 - k. Manufacturers must submit acoustical data for review and approval prior to bid indicating the proposed alternate equipment can meet all specified performance requirements. Proposals submitted which indicate a higher connected fan horsepower than specified or scheduled will not be accepted.
 - l. Multiple Fan/Motor VFD Control: Each fan motor shall be individually wired to a control panel with manual motor protection and fusing, powered by a single VFD, as specified elsewhere, for the total connected HP for all fan motors contained in

- the fan/motor assembly.
- m. Wire sizing shall be determined, and installed in accordance with applicable NEC standards.
 - n. Each VFD using a smart power module shall be driven by a “master/slave” control scheme and shall be provided with a redundant VFD in the event of a “master” VFD failure.
 - o. The manufacturer shall furnish and install a spare VFD of the same make and model as the VFD(s) being used to power the array of fans or a bank of array fans.
 - p. The VFD(s) and one spare VFD shall be furnished by the AHU manufacturer and shall be protected though a hard wired interlock to allow only one VFD to be energized at a time. Circuitries for VFD fault /failures, VFD “master” enable, VFD “slave” enable, and single fan failure or trip conditions are provided by the manufacturer for connecting with the Owner’s building automated system (BAS) for control and monitoring purposes.
 - q. Connection to the Owner’s existing BAS shall be accomplished though hard wire inputs and outputs. Gateway / Interfaces are not allowed. See Fan Array component panel requirements.
 - r. The fan/motor assembly shall produce a uniform airflow and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and filter bank face velocity when measured 12 inches from the intake side of the fan array intake plenum wall and at a distance of 48 inches from the discharge side of the fan array intake plenum wall.
 - s. Each fan/motor assembly is equipped with a metal grating fan outlet guard.
 - t. Each fan/motor assembly shall be independently isolated within a fan tower using 1-inch deflection spring isolators. Isolators shall be mounted in a three point arrangement that provides both vertical and horizontal (thrust) isolation and shall not require field adjustment. Isolation system shall be seismic rated to withstand seismic forces in excess of 2.5G horizontally and vertically. Fan/motor assemblies shall be designed such that no natural frequencies exist within the operating range of the fan, eliminating the need for "lockout" frequency settings in the variable speed drive. Non- isolated fan/motor assemblies are not acceptable.
 - u. Each fan array shall be provided with a blank off panel to isolate the inlet side of the fan/motor cube that is on standby or being removed from the fan array. Function is to prevent air bypass through a fan cube when not in operation.
 - v. One upstream blank off plate per fan array shall be provided.
 - w. The fan array shall be provided with factory installed airflow measuring devices on one fan. Airflow devices shall be mounted out of the direct air stream so as not to affect system static pressure or sound performance. Sensor accuracy shall be +/- 3%. Performance shall have been verified in an AMCA registered air chamber. Factory installed assembly shall include flow sensors for field connection to a transducer provided by others.
 - x. The manufacturer shall provide a complete spare fan/motor assembly with each one for each type of assembly provided on the project.

- y. Plug Fan (PF) SWSI Minimum Class II Fans: single width single inlet arrangement 4 as indicated on the Drawings. Fan wheel shall have a minimum of 12 blades made from extruded aluminum as a hollow airfoil in shape, and welded to the center and wheel side plates. The fan Inlet cone shall be made from spun aluminum material. Fan wheel shall be keyed to the shaft.
 - z. Fans shall be both dynamically and statically balanced. Dynamic fan wheel balancing shall be conducted from 16 Hz to 86 Hz to identify and eliminate critical speeds to ensure stable operation through the entire operating range. Each individual fan/motor assembly shall be dynamically balanced to meet AMCA 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.
 - aa. Fans shall be rated in accordance with AMCA 210 for performance and AMCA 300 for sound.
 - bb. Fan motors shall be premium efficiency with a minimum class F insulation and inverter duty rated.
 - cc. Each fan/motor assembly shall be removable through a 30" wide free area access door located on the discharge side of the fan/motor assembly.
 - dd. Bearings shall be antifriction type, either ball or roller, lubricated at the factory with extended lubrication lines where necessary to achieve bearing lubrication or solid silicon nitride (ceramic) bearings.
 - ee. Catalogued type as manufactured by Fafnir, SKF, NTN or Sealmaster; bearings shall be stocked locally.
 - ff. L-10 minimum life of 200,000 hours (direct drive application).
 - gg. Grease fittings for bearings shall be remotely mounted within line of sight of the bearing, where possible. Where line of sight is not feasible, then the fitting shall be mounted with an extended lubrication where it is most easily accessible for service. Stainless steel tubing shall be used for the remote grease fitting. If the motors are equipped with more efficient solid silicon nitride (ceramic) ball bearings, then lubrication lines are not required. Actual location to be provided in submittal for review.
2. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch (25 mm).
- a. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 20 Section 200548 "Vibration and Seismic Controls" when fan- mounting frame and air-handling-unit mounting frame are anchored to building structure.
 - b. Enclosure Type: Totally enclosed, fan cooled.
 - c. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - d. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for

electrical devices and connections specified in electrical Sections.

- f. Mount unit-mounted disconnect switches on exterior of unit.
- 3. Variable Frequency Controllers:
 - a. Refer to Division 20 Section 200514 "Variable Frequency Drives" for requirements.

E. COIL SECTION

- 1. General Requirements for Coil Section:
 - a. Comply with ARI 410.
 - b. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - c. Coils shall not act as structural component of unit.
 - d. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 20 Section 200548 "Vibration and Seismic Controls" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.
- 2. Refer to Division 23 Section 238216 "Air Coils and Drain Pans" for requirements.

F. AIR FILTRATION SECTION

- 1. General Requirements for Air Filtration Section:
 - a. Comply with NFPA 90A .
 - b. Provide minimum arrestance according to ASHRAE Std 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE Std 52.2.
 - c. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
- 2. Refer to Division 23 Section 23 41 00 "Particulate Air Filtration" for requirements.

G. DAMPERS

- 1. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm (10-m/s) face velocity through damper and 4-inch wg (1000-Pa) pressure differential.
- 2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized- steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with cadmium-plated steel operating rods rotating in stainless-steel sleeve bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch w.g. and 9 cfm/sq. ft. at 4-inch w.g..
- 3. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
- 4. Combination Filter and Mixing Section:
 - a. Cabinet support members shall hold 2 inch thick, pleated, flat, permanent or

throwaway filters.

- b. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

H. HUMIDIFIERS

- 1. Refer to Division 23 Section 238413 "Humidifiers" for requirements.

I. AIR BLENDER

- 1. Provide air blenders of size, pressure drop and capacity as indicated on drawings.
- 2. Unit casing shall be constructed to meet the applicable requirements for air handling units. Casing size shall exactly match the sizes of the upstream and downstream air handling unit modules.
- 3. The blender shall be constructed of minimum 0.080" thick aluminum.
- 4. The blender shall be capable of mixing two airstreams to within a +/-6 degree F. tolerance of the theoretical mixed air temperature when mixing 50% outside air with 50% return air at 60 degree F. inlet temperature differential, and to within a +/-4.5 deg. F tolerance when mixing 30% outside air with 70% return air at 60 degree F. inlet temperature differential.

The blender's performance range shall be from 600 FPM through 2500 FPM (blender velocity) with no loss in mixing performance.

- 5. The blender shall provide a uniform velocity profile at downstream components such as filters, coils, etc.
- 6. Blenders shall be installed per the manufacturer's instructions, including but not limited to the provision for required upstream and downstream mixing distances.
- 7. Manufacturers:
 - a. Blender Products, Inc.

PART 3 EXECUTION

3.1 APPLICATION

3.2 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

3.4 INSTALLATION

- A. Equipment Mounting:

1. Comply with requirements for vibration isolation and seismic control devices specified in Division 20 Section 200548 "Vibration and Seismic Controls."
 2. Comply with requirements for vibration isolation devices specified in Division 20 Section 200548 "Vibration Controls."
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.5 CONNECTIONS

A. Piping Connections

1. Install piping adjacent to air-handling unit to allow service and maintenance.
2. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
3. Connect condensate drain pans using NPS 1-1/4 (DN 32), {RS#591}, Type M ({RS#592}, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
4. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section 232113 "Hydronic Piping" and Division 23 Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
5. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section 232213 "Steam and Condensate Heating Piping" and Division 23 Section 232216 "Steam and Condensate Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

B. Duct Connections

1. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section 233300 "Air Duct Accessories."

C. Electrical Connections

D. Control Connections

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 3. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch w.g. or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 START UP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that shipping, blocking, and bracing are removed.
 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory- recommended lubricants.
 6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 7. Comb coil fins for parallel orientation.
 8. Install new, clean filters.
 9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.8 ADJUSTING

- A. Adjust damper linkages for proper damper operation.

- B. Comply with requirements in Division 20 Section 200593 "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.9 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237316

SECTION 238000 - HEAT TRANSFER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes:

1. Duct mounted air coils
2. Finned tube radiation
3. Fan coil units, except split system
4. Unit heaters
5. Convectors
6. Radiant ceiling panels
7. Door heaters
8. Computer room air conditioning systems

- B. Related Sections:

1. Air Coils for Air Handling Units are specified in Division 23 "Air Handling Units".
2. Reheat coils in air volume control boxes are specified with air volume control boxes in Division 23 "Ductwork and Ductwork Accessories".
3. Heat Exchangers and Heat Transfer Package are specified in Division 23 "Heat Exchangers".

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Details of custom-fabricated enclosures indicating dimensions.
 2. Location and arrangement of access panels to service piping valves and specialties.
 3. Enclosure joints, corner pieces, access doors, and other accessories.
 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Color Samples for Initial Selection: For units with factory-applied color finishes.
- D. Operation and Maintenance Data: For equipment include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of equipment and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 DUCT MOUNTED WATER COILS

- A. Acceptable Manufacturers
 - 1. Aerofin Corporation.
 - 2. Carrier Corporation.
 - 3. Dunham-Bush, Inc.
 - 4. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
 - 5. Trane.
- B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.
- D. Source Quality Control: Factory tested to 300 psig.
- E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.
- F. Fins: Aluminum, minimum 0.006 inch thick. Fin spacing maximum 10 fins per inch unless indicated otherwise.
- G. Headers: Headers constructed of Cast iron, seamless copper tube with brazed joints, or steel with brazed joints. Header and nipple designed and constructed to prevent electrolytic corrosion. Tubes staggered in direction of airflow.
- H. Coils for Cooling and Energy Recovery Service: Constructed of plate type fins with tubes mechanically or hydraulically expanded into fins to form a permanently tight metal to metal contact.
- I. Coils for Heating Service: Constructed of plate type fins with tubes mechanically or hydraulically expanded into fins to form a permanently tight metal to metal contact, or constructed of helical fins wound to the tubes to provide permanently tight metal to metal contact.
- J. Water Coils: Serpentine type. Provide coil headers with drain and vent tapings.
- K. Provide supply and return connections on same end of coil.

- L. Frames: Galvanized-steel channel frame, minimum 0.052-inch thick channel shaped for mating up to duct flanged mounting.
- M. Frames: ASTM A666, Type 304 stainless steel, minimum 0.0625-inch thick channel shaped for mating up to duct flanged mounting.

2.2 HOT-WATER FINNED-TUBE RADIATORS

- A. Acceptable Manufacturers:
 - 1. Sterling
 - 2. Vulcan Radiator Company
 - 3. Rittling, a div. of Hydro-Air Components
 - 4. Trane
- B. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
- C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One tube end shall be belled.
- D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
- E. Front Panel Enclosure: Minimum 0.0428-inch- thick steel.
- F. Wall-Mounting Back Panel: Minimum 0.0329-inch- thick steel, full height, with full-length channel support for front panel without exposed fasteners.
- G. Floor-Mounting Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounting back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.
- H. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
- I. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
- J. Damper: Knob-operated internal damper at enclosure outlet.
- K. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.
- L. Enclosure Style: Flat top.
 - 1. Front Inlet Grille: Punched louver; painted to match enclosure.
 - 2. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
 - a. Mill-finish aluminum.
 - b. Anodized finish, color as selected by Architect from manufacturer's standard colors.
 - c. Painted to match enclosure.

3. Top Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
 - a. Mill-finish aluminum.
 - b. Anodized finish, color as selected by Architect from manufacturer's standard colors.
 - c. Painted to match enclosure.

M. Accessories: End caps, filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

2.3 FAN-COIL UNITS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturer:

1. Carrier Corporation.
2. International Environmental Corporation.
3. Daikin
4. McQuay International.
5. Trane.
6. YORK International Corporation.
7. Airtherm

B. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1-inch thick, foil-covered or matte finish, closed-cell foam complying with ASTM C1071 and attached with adhesive complying with ASTM C916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84.

D. Main and Auxiliary Drain Pans: Insulated galvanized steel with plastic liner formed to slope from all directions to the drain connection as required by ASHRAE 62. Insulated and sleeved extension pan for cooling coils.

E. Chassis: Minimum 18 gauge galvanized steel chassis. Removable fan deck including fan, housing and motor, drain pan and filter. Floor-mounted vertical units shall have leveling screws.

F. Cabinet (Exposed Units): Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

1. Vertical Freestanding Cabinet Unit Panels: 18 gauge steel with solid back panel. 16 gauge steel insulated and removable front panel with integral stamped, louver type top discharge grille. Flush access door in top for fan and temperature controls. Return air subbase of required height to suit installation.
2. Recessed Units:
 - a. 18 gauge steel casing, leveling legs, 16 gauge steel flush type insulated front panel.

- b. Vertical Unit Front Panels: Removable, steel, with integral stamped steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
 - c. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.
- 3. Provide tamper-resistant fasteners and locks for all removable panels and access doors.
- G. Cabinets (Concealed Units): Steel with baked-enamel finish in manufacturer's standard paint color.
 - 1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
 - 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
 - 3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
 - 4. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- H. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV. 1 inch thick throwaway.
- I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- J. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, double width, centrifugal, statically and dynamically balanced; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 - 2. Motor: 3-speed split capacitor type with thermal overload protection. Permanently lubricated sleeve bearings; resiliently mounted on motor board.
 - 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
- K. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- L. Safety: Units shall be UL listed. Provide factory mounted service disconnect switch clearly labeled in cabinet to shut off power to entire unit.
- M. Control devices and operational sequences are specified in Division 25.

2.4 HOT WATER CABINET UNIT HEATERS

- A. Acceptable Manufacturers:
 - 1. Trane
 - 2. Sterling Radiator Company
 - 3. McQuay Air Conditioning

4. Airtherm Mfg
5. The Wing Co.

- B. Description: A factory-assembled and -tested unit complying with AHRI 440.
- C. Vertical, inverted vertical or horizontal, floor mounted, recessed type or concealed type as indicated complete with threespeed motor operated centrifugal fans, nonferrous tube and aluminum fin coil suitable for hot water.
- D. Louver type discharge and recirculating grilles, or duct collars as indicated, 1 inch thick throwaway type filter.

2.5 PROPELLER UNIT HEATERS

- A. Acceptable Manufacturers:
1. Trane
 2. Sterling Radiator Company
 3. McQuay Air Conditioning
 4. Airtherm Mfg.
 5. The Wing Co.
- B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- C. Comply with UL 2021.
- D. Cabinet: Removable panels for maintenance access to controls.
- E. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- F. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- G. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.
- H. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.
- I. Fan and Motor: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi. Permanently lubricated.

2.6 HOT WATER RADIANT CEILING PANEL

- A. Acceptable Manufacturers:

1. Airtex Corp
 2. Shellex Corp
 3. Sun-El Corp
- B. Construct panel of nonperforated 0.040 inch aluminum face plate with 1/2 inch copper serpentine coil metallurgically bonded to face plate and 1 inch thick 3/4 pound density glass fiber pads. Maximum weight 1.5 pounds per square foot when filled with water.
- C. Design for in ceiling system shown on the Architectural Drawings. Include all necessary trim.
- D. Finish with standard white paint.

2.7 ELECTRIC RADIANT CEILING PANEL

- A. Acceptable Manufacturers:
1. Aztec International
 2. Airtex Corp
 3. TVI Energy Corp
- B. UL listed, voltage as scheduled. White textured surface suitable to stand alone or be field painted.
- C. Design for installation in ceiling system shown on the Architectural Drawings. Include all necessary trim.
- D. Panel installed in toilet rooms and shower rooms shall be constructed as recommended by manufacturer for high moisture area installation.
- E. Provide 24volt wall mounted room thermostat and transformer.

2.8 DOOR HEATER

- A. Acceptable Manufacturers:
1. The Wing Co.
 2. Mars Air Door
 3. Berner International Corp.
- B. Unit designed to produce a strong, low turbulence airstream with average velocity at nozzle of 1,600 fpm on low speed and 2,100 fpm on high speed and consisting of mounting plate, power unit with coils and cover housing.
- C. Wall Mounting Plate: 16 gauge aluminized steel.
- D. Power Unit: Two-speed, open, dripproof, permanent split capacitor, double shafted motor(s) with built-in thermal overload protection mounted on base frame of 16 gauge steel. Double inlet forward curved steel fan wheel mounted on motor shafts and in matching fan housing with inlet venturies. Full width 2.5 inch deep nozzle equipped with two aluminum vanes adjustable $\pm 20^\circ$.

- E. Coil: Single row coil made of copper tubing with aluminum fins, designed for 250 psig and 320° F. hot water with fuse links, two automatic reset thermal overloads, magnetic contactor, control transformer for 120 V control wiring and built-in selector switch for heater operation. Heater assembly prewired and mounted on base frame.
- F. Cover Housing: Constructed of 0.050 inch satin anodized aluminum and equipped with a satin anodized aluminum inlet grille. Unit internally wired to a junction box and operated by a high/low/off switch. Housing removable without disconnecting any wiring. Provide leads in junction box for controlling operation of heater with a remote mounted thermostat. Sound level measured 10 feet away from unit in free field shall be no more than 54 dBA on low speed and 59 dBA on high speed.
- G. Provide wall mount room thermostat and door switch to control unit.

2.9 COMPUTER ROOM AIR CONDITIONING SYSTEMS

A. Acceptable Manufacturers:

- 1. Liebert Corporation
- 2. Data Aire, Inc.
- 3. ATS/Stulz

B. Ceiling Mounted Units

- 1. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of
- 2. cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit 24-by-48-inch
- 3. T-bar ceiling opening.
- 4. Cabinet: Galvanized steel with baked-enamel finish, insulated with ½-inch-thick duct liner.
- 5. Evaporator Fan: Forward curved, centrifugal, and directly driven by two-speed motor.
 - a. Motor: Comply with requirements in Division 23 Section “Electrical Requirements for HVAC Equipment.”
 - 1) Noise Rating: Quiet.
- 6. Chilled-Water Coil: Seamless copper tubes expanded into aluminum fins with modulating control valve. Mount coil assembly over stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
- 7. Filter: 1-inch-thick pleated filter.
- 8. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
 - a. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap on drain.
 - b. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field adjustable maximum capacity; with high-water probe.

- c. Drain Cycle: Field-adjustable drain duration and drain interval.
 - 9. Control System: Unit-mounted panel with main fan contactor, control transformer with circuit breaker, solid-state temperature- and humidity-control modules, humidity contactor, and high-temperature thermostat. Provide solid-state, wall-mounting control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.
- C. Console Units
- 1. Description: Chilled Water air handling section for floor or wall mounting.
 - 2. Cabinet: Furniture-grade steel with baked-enamel finish; with front access and containing direct-drive centrifugal fans, two-speed motor, and cleanable foam filter.
 - a. Motor: Comply with requirements in Division 23 Section 'Electrical Requirements for HVAC Equipment.'
 - 1) Noise Rating: Quiet.
 - 3. Chilled-Water Coil: Seamless copper tubes expanded into aluminum fins with modulating control valve. Mount coil assembly over stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
 - 4. Filter: 1-inch-thick pleated filter.
 - 5. Electrode Steam Humidifier: Self-contained and microprocessor controlled; with replaceable cylinder.
 - 6. Control System: Unit-mounted panel with contactors, control transformer with circuit breaker, and solid-state temperature- and humidity-control modules. Provide solid-state, unit-mounted control panel with start-stop switch, adjustable humidity setpoint, and adjustable temperature set point.

PART 3 - EXECUTION

3.1 COIL INSTALLATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Install coils level and plumb.
- C. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- D. Install stainless-steel drain pan under each cooling coil.
 - 1. Construct drain pans according to ASHRAE 62.
 - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - 3. Extend drain pan upstream and downstream from coil face.
 - 4. Extend drain pan under coil headers and exposed supply piping.

- E. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
- F. Straighten bent fins on air coils.
 - 1. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.
- G. Install piping adjacent to coils to allow service and maintenance.
- H. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 25 Section "Instrumentation and Control for HVAC," and other piping specialties are specified in Division 23 Section "Hydronic Piping."
- I. Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control valves are specified in Division 25 Section "Instrumentation and Control for HVAC," and other piping specialties are specified in Division 23 Section "Steam and Condensate Heating Piping."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FINNED-TUBE RADIATOR INSTALLATION

- A. Install units level and plumb. Install enclosure continuously around corners, using outside and inside corner fittings. Join sections with splice plates and filler pieces to provide continuous enclosure. Install enclosure continuously from wall to wall. Terminate enclosures with manufacturer's end caps, except where enclosures are indicated to extend to adjoining walls.
- B. Install access doors for access to valves. Install valves within reach of access door provided in enclosure.
- C. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping." Install shutoff valves on inlet and outlet, and balancing valve on outlet. Install control valves as required by Division 25 Section "Instrumentation and Control for HVAC Systems."
- D. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.
- E. Install piping within pedestals for freestanding units.

3.3 FAN COIL UNIT INSTALLATION

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Install fan-coil units level and plumb. Install fan-coil units to comply with NFPA 90A.

- C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC."
- D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.
- E. Install piping adjacent to machine to allow service and maintenance. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
- F. Connect condensate drain to indirect waste.
- G. For cooling coil unit suspended above finished areas above ceilings, provide auxiliary drain pan not less than 3 inches larger than unit or coil and pipe discharge to a conspicuous point of disposal to alert occupants of an overflow or leak condition. Pan shall have minimum depth of 1-1/2 inches.
- H. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- I. Connect supply and return ducts to fan-coil units with flexible duct connectors. Comply with safety requirements in UL 1995 for duct connections.
- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 UNIT HEATER INSTALLATION

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Install propeller unit heaters level and plumb.
- D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.
- F. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
- G. Comply with safety requirements in UL 1995.

- H. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."
- I. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in Division 23 Section "Steam and Condensate Heating Piping."
- J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 COMPUTER ROOM AIR CONDITIONING UNIT INSTALLATION

- A. Install computer-room air conditioning units level and plumb, maintaining manufacturer's recommended clearances.
- B. Use qualified mechanics and thoroughly check equipment at site for leaks and loose connections in accordance with manufacturer's instructions.
- C. Support suspended units from structure using threaded steel rods and spring hanger having 1-inch deflection. Vibration-control devices and installation requirements are specified in Division 23 Section "Vibration Isolation and Seismic Restraints for HVAC Systems."
- D. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.
- E. Water and Drainage Connections: Comply with applicable requirements in Division 23 Section "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
- F. Chilled Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Provide shutoff valves in inlet and outlet piping to coils.
- G. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 238000

SECTION 238123 - COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Floor-mounted computer-room air conditioners, 6 tons and larger.
 - 2. Floor-mounted computer-room air conditioners, 5 tons and smaller.
 - 3. Ceiling-mounted computer-room air conditioners.
 - 4. Console computer-room air conditioners.

1.3 DEFINITION

- A. BAS: Building automation system.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Computer-room air conditioners shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[and the unit will be fully operational after the seismic event]."

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Seismic Qualification Certificates: For computer-room air conditioners, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- D. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.
- E. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1
- D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.7 COORDINATION

- A. Coordinate layout and installation of computer-room air conditioners and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate installation of computer-room air conditioners with computer-room access flooring Installer.
- C. Coordinate sizes and locations of concrete bases with actual equipment provided.
- D. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.
 - 3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fan Belts: One set(s) for each belt-driven fan.
 - 2. Filters: One set(s) of filters for each unit.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED UNITS 6 TONS AND LARGER

- A. Manufacturers: Subject to compliance with requirements, [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. Compu-Aire, Inc.
 - 2. Data Aire Inc.
 - 3. Liebert Corporation.
- B. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.
- C. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.
 - 1. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges, and concealed fastening devices.
 - 2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch- thick duct liner.
 - 3. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - 4. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors.
 - 5. Floor Stand: Welded tubular steel, 12" high (minimum), with adjustable legs and vibration isolation pads.
- D. Supply-Air Fan(s):
 - 1. Double-inlet, forward-curved centrifugal fan(s); statically and dynamically balanced.
 - 2. Drive: V-belt, with steel shaft with self-aligning ball bearings and cast-iron or steel sheaves, variable- and adjustable-pitch motor sheave, minimum of two matched belts, with drive rated at a minimum of two times the nameplate rating of motor.
- E. Refrigeration System:
 - 1. Compressors: Semihermetic reciprocating; with suction-gas-cooled, 1750-rpm motors; thermal overloads; oil sight glass; suction-line strainer; and reversible oil pumps; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 - 2. Compressors: Hermetic reciprocating; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 - 3. Compressors: Hermetic scroll; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 - 4. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.

5. Refrigerant: R-407C or R-410A.
 6. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
 7. Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel and disconnect switch. Control capacity by modulating fan speeds.
- F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating two-way control valve.
1. Cooling Medium: Water
 2. Control Valve: Class 125 body.
 - a. Maximum Pressure Drop: 3 psig at design flow rate.
 - b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
 3. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
- G. Electric-Resistance Heating Coil: Enclosed finned-tube electric elements arranged for minimum of three stages, with thermal safety switches, manual-reset overload protection, and branch-circuit overcurrent protection.
- H. Hot-Water Heating Coil: Seamless copper tubes expanded into aluminum fins with two-way modulating control valve and strainer.
1. Control Valve: Class 125 body.
 - a. Maximum Pressure Drop: 3 psig at design flow rate.
 - b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- I. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame with 2-inch-thick, disposable, glass-fiber prefilter.
- J. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.
- K. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- L. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.
1. Malfunctions:

- a. Power loss.
 - b. Loss of airflow.
 - c. Clogged air filter.
 - d. High room temperature.
 - e. Low room temperature.
 - f. High humidity.
 - g. Low humidity.
 - h. Smoke/fire.
 - i. Water under floor.
 - j. Supply fan overload.
 - k. Compressor No. 1 - Overload.
 - l. Compressor No. 1 - Low Pressure.
 - m. Compressor No. 1 - High Pressure.
 - n. Compressor No. 2 - Overload.
 - o. Compressor No. 2 - Low Pressure.
 - p. Compressor No. 2 - High Pressure.
2. Digital Display:
 - a. Control power on.
 - b. Humidifying.
 - c. Dehumidifying.
 - d. Compressor No. 1 - Operating.
 - e. Compressor No. 2 - Operating.
 - f. Heat operating.
 - g. Economy cooling.
3. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.
4. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.
 - a. Hardwired Points:
 - 1) Monitoring: On-off status, common trouble alarm, space temperature, space humidity
 - 2) Control: On-off operation, space temperature set-point adjustment, space relative humidity set-point adjustment.
 - b. ASHRAE 135 (BACnet) interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

2.2 FLOOR-MOUNTED UNITS 5 TONS AND SMALLER

- A. Manufacturers: Subject to compliance with requirements, [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 1. Compu-Aire, Inc.
 2. Data Aire Inc.
 3. Liebert Corporation.
- B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.
- C. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with 1-inch- thick duct liner.

1. Floor Stand: Welded tubular steel, 12" high (minimum), with adjustable legs and vibration isolation pads.
 2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Supply-Air Fan: Forward curved, centrifugal, and with adjustable V-belt drive.
- E. Refrigeration System:
1. Compressors: Semihermetic reciprocating; with suction-gas-cooled, 1750-rpm motors; thermal overloads; oil sight glass; suction-line strainer; and reversible oil pumps; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 2. Compressors: Hermetic reciprocating; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 3. Compressors: Hermetic scroll; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 4. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
 5. Refrigerant: R-407C or R-410A.
 6. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
 7. Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel and disconnect switch. Control capacity by modulating fan speeds.
- F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating two-way control valve.
1. Cooling Medium: Water
 2. Control Valve: Class 125 body.
 - a. Maximum Pressure Drop: 3 psig at design flow rate.
 - b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
 3. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
- G.
- H. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor and high-temperature-limit switches.
- I. Filter: 2-inch- thick, disposable, glass-fiber media.

- J. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- K. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- and humidity-control modules, humidity contactor, time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.

2.3 CEILING-MOUNTED UNITS

- A. Manufacturers: Subject to compliance with requirements, [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - 1. Compu-Aire, Inc.
 - 2. Data Aire Inc.
 - 3. Liebert Corporation.
- B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit T-bar ceiling opening of 24 by 48 inches.
- C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch- thick duct liner.
 - 1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches, with filter.
 - 2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.
- E. Refrigeration System:
 - 1. Compressors: Semihermetic reciprocating; with suction-gas-cooled, 1750-rpm motors; thermal overloads; oil sight glass; suction-line strainer; and reversible oil pumps; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 - 2. Compressors: Hermetic reciprocating; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 - 3. Compressors: Hermetic scroll; with oil strainer, internal motor overload protection, resilient suspension system, crankcase heater, manual-reset high-pressure switch, and pump-down low-pressure switch.
 - 4. Refrigeration Circuits: Two; each with hot-gas mufflers, thermal-expansion valve with external equalizer, liquid-line solenoid valve, liquid-line filter-dryer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
 - 5. Refrigerant: R-407C or R-410A.
 - 6. Refrigerant Evaporator Coil: Alternate-row or split-face-circuit, direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
 - 7. Remote Air-Cooled Refrigerant Condenser: Corrosion-resistant cabinet, copper-tube aluminum-fin coils arranged for two circuits, multiple direct-drive propeller fans with

permanently lubricated ball bearings, and single-phase motors with internal overload protection and integral electric control panel and disconnect switch. Control capacity by modulating fan speeds.

- F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating two-way control valve.
 - 1. Cooling Medium: Water
 - 2. Control Valve: Class 125 body.
 - a. Maximum Pressure Drop: 3 psig at design flow rate.
 - b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
 - 3. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
- G. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor, dehumidification relay, and high-temperature-limit switches.
- H. Filter: 1-inch- thick, disposable, glass-fiber media.
- I. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- J. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- and humidity-control modules, humidity contactor, time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B.

- B. Computer-Room Air-Conditioner Mounting: Install using elastomeric mounts or restrained spring isolators. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of computer-room air conditioner.
 - 1. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required.
 - 2. Comply with requirements for hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- D. Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric mounts or restrained spring isolators. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Water and Drainage Connections: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
- D. Hot-Water Heating Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Provide shutoff valves in inlet and outlet piping to heating coils.
- E. Chilled-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Provide shutoff valves in water inlet and outlet piping on water-cooled units.
- F. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 238123

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. LEED Submittals:
 - 1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
 - 2. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1-2013, Section 5 - "Systems and Equipment."
- C. Shop Drawings: Diagram power, signal, and control wiring.
- D. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2013, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IESNA 90.1-2013 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2013, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

- A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."
- B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: [**Five**] <**Insert other number**> years from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set of filters for each unit.
 - 2. Fan Belts: One set of belts for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Carrier Air Conditioning; Div. of Carrier Corporation.
 - 2. Lennox Industries Inc.
 - 3. Mitsubishi Electronics America, Inc.; HVAC Division.
 - 4. Trane Company (The); Unitary Products Group.
 - 5. York International Corp.
 - 6. Liebert: Vertiv Group

2.2 CEILING-MOUNTING, EVAPORATOR-FAN COMPONENTS

- A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
 - 1. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2013.
 - 2. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2013.
- B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

- C. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.
- D. Fan: Direct drive, centrifugal fan and integral condensate pump.
- E. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.
- F. Filters: 30% efficiency.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

- A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - 1. Compressor Type: Scroll.
 - 2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
- E. Fan: Aluminum-propeller type, directly connected to motor.
- F. Motor: Permanently lubricated, with integral thermal-overload protection.
- G. Low Ambient Kit: Permits operation down to 45 deg F.
- H. Mounting Base: Polyethylene.
- I. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2013, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Automatic-reset timer to prevent rapid cycling of compressor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounting, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- D. Install ground-mounting, compressor-condenser components on polyethylene mounting base.
- E. Install roof-mounting compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- F. Install seismic restraints.
- G. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- H. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238126

SECTION 238413 - HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Duct Mounted Humidifier
- B. Related Sections:
 - 1. Humidifiers for Air Handling Units are specified in Division 23 "Air Handling Units"

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with ARI 640, "Commercial and Industrial Humidifiers."
- C. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 PANEL TYPE HUMIDIFIER

- A. Acceptable Manufacturers:
 - 1. Armstrong International, Inc.
 - 2. DRI-STEEM Humidifier Company
 - 3. Nortec Industries Inc.
 - 4. Pure Humidifier Company
- B. Packaged panel assembly of steam dispersing tubes connected to a steam supply header/separator and, if required by manufacturer's design and construction, a condensate return header, all constructed of Type 304 stainless steel and contained within a galvanized metal casing. Tubes fitted with nonmetallic steam discharge tublets with steam orifices.
- C. Provide insulated dispersion tube. Insulation shall be suitable for use in wet/hot humidifier applications.
- D. Select panel size, tube spacing and number of orifices for maximum absorption distance at scheduled face velocity. Absorption distance 18 inches maximum at 52° DB and 90% RH supply air with panel face velocity up to 1500 ft. per minute. Air pressure loss not to exceed 0.26 inches w.g. at panel face velocity of 1500 ft. per minute.
- E. Provide manufacturer's full modulating electric valve properly orificed, inlet strainer and steam trap(s), all constructed of Type 304 stainless steel and shipped loose for field installation.
- F. Include with submittal factory published/calculated absorption distance and air pressure drop for actual installed velocity at maximum and minimum flow conditions and design temperature conditions at 90% minimum duct relative humidity.
- G. Integral Condensate Management: Heat exchanger to vaporize dispersion generated condensate for return to low pressure condensate piping.
- H. Accessories:
 - 1. Airflow switch for preventing humidifier operation without airflow

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine duct layout at location of humidifier, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Install humidifiers with required clearance for service and maintenance.
- C. Seal humidifier manifold duct or plenum penetrations with flange.

- D. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- E. Install manifold supply piping pitched to drain condensate back to humidifier.
- F. Install drip leg upstream from steam trap a minimum of 12 inches tall for proper operation of trap.
- G. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Install piping adjacent to humidifiers to allow service and maintenance.
- H. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238413

SECTION 260010 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

- A. Basic Requirements: The Drawings and general provisions of the Contract, including General and Supplementary Conditions.
- B. General Provisions: Provide all labor, materials, equipment, and incidentals required to make ready for use complete electrical systems as specified herein and shown on the drawings.
- C. Provide and Install: The word "provide" where used on the Drawings or in the Specifications shall mean "furnish, install, mount, connect, test, complete, and make ready for operation". The word "install" where used on the Drawings or in the Specifications shall mean "mount, connect, test, complete, and make ready for operation". Perform work required by, and in accordance with, the Contract Documents.
- D. Installation: Provide and place in satisfactory condition, ready for proper operation, raceways, wires, cables, and other material needed for all complete electrical systems required by the Contract Documents. Additional raceways and wiring shall be provided to complete the installation of the specific equipment provided. Include auxiliaries and accessories for complete and properly operating systems. Provide electrical systems and accessories to comply with the NEC, state and local codes and ordinances. It is the intent of these Specifications that the electrical systems be suitable in every way for the use intended. Material and work which is incidental to the work of this Contract shall be provided at no additional cost to the Contract.
- E. Field Connections: Provide field connections to remote equipment and control panels provided under other Divisions of these Specifications. Provide raceway, wire, and interconnections between equipment, transmitters, local indicators, and receivers. Provide 120V and low voltage surge protection equipment as required. Install field connections to "packaged" equipment provided under other Divisions of these Specifications.

1.2 SCOPE OF WORK

- A. General: Provide labor, materials, permits, inspections and re-inspection fees, tools, equipment, transportation, insurance, temporary protection, temporary power and lighting, supervision and incidental items essential for proper installation and operation of the Electrical systems indicated in the Contract Documents. Provide materials not specifically mentioned or indicated but which are usually provided or are essential for proper installation and operation of the Electrical systems indicated in the contract documents.
- B. Notices: Give notices, file Plans, pay fees, and obtain permits and approvals from authorities having jurisdiction. Include all fees in the Bid Price.

1.3 INTERPRETATION OF DRAWINGS

- A. General: The Drawings are diagrammatic and are not intended to show exact locations of Raceway runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, Raceways, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be determined and coordinated in the field. The right is reserved to change, without additional cost, the location of any outlet within the same room

or general area before it is permanently installed. Obtain all information relevant to the placing of electrical work and in case of interference with other work, proceed as directed by the Architect.

- B. Discrepancies: Notify the Architect of any discrepancies found during construction of the project. The Architect will provide written instructions as to how to proceed with that portion of work. If a conflict exists between the Contract Documents and an applicable code or standard, the most stringent requirement shall apply.
- C. Wiring: Each three-phase circuit shall be run in a separate Raceway unless otherwise shown on the Drawings. Unless otherwise accepted by the Architect, Raceway shall not be installed exposed. Where circuits are shown as "home-runs" all necessary fittings, supports, and boxes shall be provided for a complete raceway installation.
- D. Layout: Circuit layouts are not intended to show the number of fittings, or other installation details. Connections to equipment shall be made as required, and in accordance with the accepted shop and manufacturer's setting drawings.
- E. Coordination: Coordinate final equipment locations with drawings or other disciplines. Layout before installation so that all trades may install equipment in available space. Provide coordination as required for installation in a neat and workmanlike manner.
- F. Device Counts: When equipment/product counts are different between disciplines, the greater number and highest cost shall be included in contractor's base price. Contractor shall review all contract drawings and include as a pre-bid RFI any discrepancies found. This includes but is not limited to:
 - a. Light fixtures (between architectural RCP and electrical lighting plans)
 - b. Outlets and switches (between architectural elevations and electrical power and lighting plans). Any outlet shown on arch elevations but not on electrical drawing shall be considered a dedicated emergency circuit
 - c. Fire smoke dampers and smoke duct detectors (between mechanical and electrical plans)
 - d. Medical equipment plans & and electrical drawings. Any outlet required by medical equipment plans but not on electrical drawing shall be considered a dedicated emergency circuit.

1.4 EQUIPMENT SIZE AND HANDLING

- A. Coordination: Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, ship the equipment in sections of specific sizes to permit the passing through the necessary areas within the structure.
- B. Handling: Equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.5 RECORD DRAWINGS

- A. Production: The Contractor shall provide two (2) sets of black or blue line on white drawings to maintain and submit record "As-Built Documents". Label each sheet of the Record Document set with "Project Record Documents" with company name of the installing contractor in

stamped or printed letters. One set shall be maintained at the site and at all times be accurate, clear, and complete. These drawings shall be available at all times to the Architect's field representatives.

- B. Recording: Record information concurrent with construction progress. Make entries within 24 hours upon receipt of information. The "As-Built" drawings shall accurately reflect installed electrical work specified or shown on the Contract Documents.
- C. Completion: At the completion of the Work, transfer changes with a colored pencil onto the second set and submit to the Architect. The "As-Built" drawings shall be made available to the Architect to make the substantial completion punch list.
- D. Final: Upon Contractor's completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings and CAD files. Submit drawings and CAD disks for review and acceptance. The Contractor shall provide updated disks which include final As-Built conditions.

1.6 ABBREVIATIONS

- A. Abbreviations: The following abbreviations or initials may be used:

A/C	Air Conditioning
AC	Alternating Current
ABV CLG	Above Ceiling
ADA	Americans with Disabilities Act
AF	Ampere Frame
AFF	Above Finished Floor
AFG	Above Finished Grade
AHU	Air Handler Unit
AIC	Amps Interrupting Capacity
AL	Aluminum
AMP	Ampere
ANSI	American National Standards Institute
ASA	American Standards Association
AT	Ampere Trip
ATS	Automatic Transfer Switch
AUX	Auxiliary
AWG	American Wire Gauge
BC	Bare Copper
BIL	Basic Impulse Level
BMS	Building Management System
BRKR or BKR	Breaker
CAB	Cabinet
C	Conduit or Raceway
CB	Circuit Breaker
CBM	Certified Ballast Manufacturers
CCTV	Closed Circuit Television
CKT	Circuit
CLEC	Clock Equipment Cabinet
CLG	Ceiling
CO	Conduit or Raceway Only
COAX	Coaxial Cable

COND	Conductor
CONN	Connection
CPU	Central Processing Unit
CRT	Cathode Ray Terminal (Video display terminal)
CT	Current Transformer
CU	Copper
CW	Cold Water
DC	Direct Current
DDC	Direct Digital Control
DEG	Degree
DISC	Disconnect
DO	Draw Out
DN	Down
DPST	Double Pole Single Throw
EMT	Electrical Metallic Tubing
EO	Electrically Operated
EOL	End of Line Resistor
EWC	Electric Water Cooler
FAAP	Fire Alarm Annunciator Panel
FACP	Fire Alarm Control Panel
FCU	Fan Coil Unit
FLA	Full Load Amperes
FM	Factory Mutual
GF	Ground Fault
GFCI	Ground Fault Circuits Interrupter
GND	Ground
HOA	Hand-Off-Automatic
HORIZ	Horizontal
HP	Horsepower
IC	Intercom
ICU	Intensive Care Unit
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMC	Intermediate Metallic Raceway
IN	Inches
IT	Instantaneous Trip
IPCEA	Insulated Power Cable Engineers Association
JB	Junction Box
KCMIL	Thousand Circular Mills
KV	Kilovolt
KVA	Kilo-Volt-Amps
KW	Kilowatts
LBS	Pounds
LED	Light Emitting Diode
LT	Light
LTD	Long Time Delay
LTT	Long Time Trip
LTG	Lighting
MAX	Maximum
MCB	Main Circuit Breaker

MCC	Motor Control Center
MCP	Motor Circuit Protector
MIC	Microphone
MIN	Minimum
MLO	Main Lugs Only
MTD	Mounted
MTG	Mounting
MUX	Multiplex (Transponder) Panel
MVA	Mega Volt Amps
N	Neutral
NC	Normally Closed
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIC	Not in Contract
NF	Non Fused
NL	Non Linear
NO	Number or Normally Open
#	Number
Ø	Phase
OL	Overload
OSHA	Occupational Safety and Health Administration
P	Pole
PB	Pullbox
PIV	Post Indicator Valve
PNL	Panel
PR	Pair
PWR	Power
PF	Power Factor
PRI	Primary
PT	Potential Transformer
PVC	Polyvinylchloride
REF	Refrigerator
RGC or GRC	Rigid Galvanized Raceway
RMS	Root-Mean-Square
RPM	Revolutions Per Minute
RECPT	Receptacle
SCA	Short Circuit Amps
SD	Smoke Detector
SEC	Secondary
S/N	Solid Neutral
SPKR	Speaker
SPST	Single Pole Single Throw
SST	Solid State Trip
ST	Short Time Trip
STD	Short Time Delay
SW	Switch
SWGR	Switchgear
SWBD	Switchboard

TEL	Telephone
TTB	Telephone Terminal Board
TTC	Telephone Terminal Cabinet
TVEC	Television Equipment Cabinet
TYP	Typical
UL	Underwriters Laboratories
UON	Unless Otherwise Noted
V	Volt
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
W	Wire
WP	Weatherproof
XFMR	Transformer

1.7 CODES, FEES, AND STANDARDS

- A. Application: The codes, standards and practices listed herein generally apply to the entire project and specification sections. Other codes, standards or practices that are more specific will be referenced within a particular specification.
- B. Requirements: All materials and types of construction covered in the specifications will be required to meet or exceed applicable standards of manufacturer, testing, performance, and installation according to the requirements of UL, ANSI, NEMA, IEEE, and NEC referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents that exceed but are not contrary to governing codes shall be followed.
- C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed electrical installation shall be inspected and certified by applicable agencies that it is in compliance with codes.
- D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements.
 - 1. As stated on electrical lead sheet.
- E. Utility Company: Comply with latest utility company regulations.
- F. Building Code: IBC 2018.
- G. Labels: Materials and equipment shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available or desired for certain types of equipment, test data shall be submitted to validate that equipment meets or exceeds available standards.

1.8 INVESTIGATION OF SITE

- A. General: Before commencing work, verify existing conditions at the premises including, but not limited to, existing structural frame, existing openings; existing wall and partition locations,

existing mechanical and electrical work, equipment type, and examine adjoining work on which work is in anyway dependent.

- B. Responsibility: No waiver of responsibility for defective and inadequate work or additional cost as a result of existing conditions which should have been verified shall be considered unless notice of same has been filed by the Contractor and agreed to in writing by the Architect before the bid date.
- C. Site Renovation: Verify and coordinate existing site raceways and pipes at any excavation on site. Provide hand-digging and required rerouting in areas of existing Raceways and pipes within bid price.
- D. Renovation: Investigate site thoroughly and reroute raceway and wiring in area of new construction in order to maintain continuity of existing circuitry. Existing Raceways shown on plans show approximate locations only.
- E. Special Considerations: Special attention is called to the fact that there will be piping, fixtures or other items in the existing building which must be removed or relocated in order to perform the alteration work. Include removal and relocation required for completion of the alterations and the new construction. All existing wiring that is to remain in renovated areas shall be made code compliant.
- F. Power Outage: Special attention is called to the fact that work involved is in connection with existing buildings which shall remain in operation while work is being performed. Work must be done in accordance with the priority schedule. Schedule work for a minimum outage to Owner. Request written permission and receive written acceptance from the Owner no later than 10 days in advance of power and communication shut-downs. Perform work required at other than standard working hours where outages cannot be accepted by Owner during regular working hours. Protect existing buildings and equipment during construction.

1.9 SUPERVISION OF THE WORK

- A. Supervision: Provide one field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable sizes, type and complexity. The Superintendent shall be present at all times when work is being performed. At least one member of the Electrical Contracting Firm shall hold a State Master Certificate of Competency.

1.10 COORDINATION

- A. General: Compare drawings and specifications with those of other trades and report any discrepancies between them to the Architect. Obtain from the Architect written instructions to make the necessary changes in any of the affected work. Work shall be installed in cooperation with other Trades installing interrelated work. Before installation, Trades shall make proper provisions to avoid interferences in a manner approved by the Architect.
- B. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:

1. Door hardware
 2. Signage
 3. Fire shutters
 4. Sliding or automatic doors
 5. Mechanical Divisions of the Specifications
 6. Medical equipment
 7. Imaging equipment
 8. Interior design drawings
 9. Fountains
 10. Millwork design drawings and shop drawings
- C. Obtain set of Contract Documents from Owner's Authorized Representative or Contractor for all areas of work noted above and include all electrical work in bid whether included in Division 26 Contract Documents or not.
- D. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed.
- E. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.
- F. Adjustments: Locations of raceway and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of systems prior to fabrication or installation.
- G. Priorities: Lines which pitch shall have the right of way over those which do not pitch. For example, plumbing drains shall normally have the right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.
- H. Modifications: Offsets and changes of direction in raceway systems shall be made to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Provide elbows, boxes, etc., as required to allow offsets and changes to suit job conditions.
- I. Replacement: Work shall be installed in a way to permit removal (without damage to other parts) of other system components provided under this Contract requiring periodic replacement or maintenance. Raceway shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.
- J. Layout: The Contract Drawings are diagrammatic only intending to show general runs and locations of raceway and equipment, and not necessarily showing required offsets, details and accessories and equipment to be connected. Work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation, which will afford maximum accessibility for operation, maintenance and headroom.
- K. Contract Conflicts: Where discrepancies exist in the Scope of Work as to what Trade provides items such as starters, disconnects, flow switches, etc. such conflicts shall be coordinated between the divisions involved. It is the intent of the Contract Documents that all work shall be provided complete as one bid price.

- L. Drawing Conflicts: Where drawing details, plans or specification requirements are in conflict and where sizes of the same item run are shown to be different within the contract documents, the most stringent requirement shall be included in the Contract. Systems and equipment called for in the specification or as shown on the drawings shall be provided as if it was required by both the drawings and specifications. Prior to ordering or installation of any portion of work, which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.
- M. It is the responsibility of this Contractor to coordinate the exact required location of floor outlets, floor ducts, floor stub-ups, etc. with Owner's Authorized Representative and Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.
- N. The Contract Documents describe specific sizes of switches, breakers, fuses, Raceways, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. Adjust circuit breaker, fuse, Raceway, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.
- O. Working Clearances: Minimum working clearances about electrical equipment shall be as referenced in the applicable edition NEC Article 110, and shall include equipment installed in ceiling spaces.

1.11 COORDINATION STUDY

- A. Specified Manufacturers: All panelboard and circuit breakers shall be of the manufacturer and type specified herein, and as indicated on the drawings or the Coordination Study. Any discrepancies or conflicts in specified equipment shall be brought to the attention of the engineer during bid, for formal clarification.
- B. Basis of Design: Square D
- C. Substitutions: Alternate manufacturers listed will be considered under the following conditions:
 - 1. Written approval of the Owner to consider alternate manufacturer.
 - 2. Ability of alternate manufacturer to meet the requirements of the Construction Documents.
 - 3. Alternate equipment selection shall provide selective overcurrent device coordination, including coordination with existing equipment.
 - 4. Submission of coordination plots, showing proper selective coordination of proposed equipment for reference and review. Provide coordination plots for all distribution branches indicated on Construction Documents.

1.12 DEMOLITION

- A. General: Relocate existing equipment and reroute existing raceways in areas being renovated as required to facilitate the installation of the new systems. The Owner shall require continuous

operation of the existing systems, while demolition, relocation work or new tie-ins are performed.

- B. Coordination: Prior to any deactivation, relocation or demolition work, arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect equipment designated as being relocated and reused or equipment remaining in operation and integrated with the new systems.
- C. Provisions: Deactivation, relocation, and temporary tie-ins shall be provided by the Contractor. Demolition, removal and the legal disposal of demolished materials shall be provided by the Contractor.
- D. Owner's Salvage: The Owner reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
- E. Phasing: The Contractor shall perform work in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Specified Method: Where several brand names, make or manufacturers are listed as acceptable each shall be regarded as equally acceptable, based on the design selection but each must meet all specification requirements. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance. No substitutions are permitted.
- B. Certification: When a product is specified to be in accordance with a trade association or government standard requested by the Engineer, Contractor shall provide a certificate that the product complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
- C. Basis of Bid: Each bidder represents that his bid is based upon the manufacturer's, materials, and equipment described in the Contract Documents.
- D. Space Requirements: Equipment or optional equipment shall conform to established space requirements within the project. Equipment which does not meet space requirements, shall be replaced at no additional expense to the Contract. Modifications of related systems shall be made at no additional expense to the Contract. Submit modifications to the Architect/Engineer for acceptance.
- E. Samples: Samples are to be submitted for items requested within Specification Sections to determine that the item meets specifications and requirements before being accepted for use on Project. Samples shall be submitted within 30 days after the award of the contract. Each sample shall be tagged, labeled, or marked, "Sample of for (Project). Accompany samples with copy, in duplicate of manufacturer's instructions regarding installation, and maintenance.

2.2 SHOP DRAWINGS

- A. General: Shop drawings shall be submitted for every item listed within the Submittals section each individual specification section. One copy shall be submitted to the engineer prior to ordering equipment. Refer to Basis of approval paragraph.
- B. Responsibility: It is the Contractors responsibility to provide material in accordance with the plans and specifications. Material not provided in accordance with the plans and specifications shall be removed and replaced at the Contractors expense.
- C. Official Record: The shop drawing submittal shall become the official record of the materials to be installed. If materials are installed which do not correspond to the record submittal they shall be removed from the project without any additional cost or delays in construction completion.
- D. Information: The shop drawing record submittal shall include the following information to the extent applicable to the particular item;
 - 1. Manufacturer's name and product designation or catalog number.
 - 2. Standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEMA, NFPA, OSHA, UL, or other organizations, including the type, size, or other designation.
 - 3. Dimensioned plan, sections, and elevations showing means for mounting, raceway connections, and grounding, and showing layout of components.
 - 4. Materials and finish specifications, including paints.
 - 5. List of components including manufacturer's names and catalog numbers.
 - 6. Internal wiring diagram indicating connections to components and the terminals for external connections.
 - 7. Manufacturer's instructions and recommendations for installation, operation, and maintenance.
 - 8. Manufacturer's recommended list of spare parts.
 - 9. Provide 1/2" = 1'-0" enlarged electrical room layout drawings for all electrical rooms. All equipment shall be indicated at actual size of equipment being provided. All dimensions and required working clearances shall be shown.
- E. Coordination Study: This project has been designed and coordinated (electrical distribution system) utilizing the specified manufacturer(s).
- F. Preparation: Prior to submittal, shop drawings shall be checked for accuracy and contract requirements. Shop drawings shall bear the date checked and shall be accompanied by a statement that the shop drawings have been examined for conformity to Specifications and Drawings. This statement shall also list discrepancies with the Specifications and Drawings. Shop drawings not so checked and noted shall be returned to Contractor unreviewed.

- G. Basis of Review: Approval is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Contractor is responsible for quantities, dimensions, fabrication processes, and construction techniques.
- H. Responsibility: The responsibility that dimensions are confirmed and correlated with proper coordination of other trades shall be included as part of the Contract Documents. The responsibility and the necessity of providing materials and workmanship required by the Specifications and Drawings which may not be indicated on the shop drawings shall be included as part of the Contract Documents. The Contractor is responsible for any delays in job progress occurring directly or indirectly from late submissions or re-submissions of shop drawings, product data, or samples.
- I. Ordering Equipment: No material shall be ordered or shop work started until the Engineer has officially received the shop drawings record submittal and has formally released the Contractor for submittal requirements.
- J. Brochure Requirements: Submit Technical Information Brochures at the start of construction or no later than 30 days after Award of the Contract. Electronic Submission is acceptable.
- K. Brochure Contents: First sheet in the brochure shall be a photocopy of the Electrical Index pages in these specifications. Second sheet shall be a list of Project Addresses for this project. Third sheet shall list Project Information. Provide reinforced separation sheets tabbed with the appropriate specification reference number and typed index for each section in the Electrical Schedule. Technical Information consisting of marked catalog sheets or shop drawings shall be inserted in the brochure in proper order on all items specified and shown on drawings. At the end of the brochure, provide and insert a copy of the specifications for this Division and all addenda applicable to this Division.
- L. Contractor's Review: Review the brochures before submitting to the Engineer. No request for payment shall be considered until the brochure has been reviewed, stamped and submitted for review.
- M. Cost: Submit cost breakdown on work in the Technical Information Brochures. The cost of material and labor for each item shall be indicated. The cost of fittings and incidentals are not required.
- N. Title Drawings: Title drawings to include identification of project and names of Architect-Engineer, Engineer, Contractors, and/or supplier, data, number sequentially and indicate in general;
 - 1. Fabrication and Erection dimensions.
 - 2. Arrangements and sectional views.
 - 3. Necessary details, including complete information for making connections with other work.
 - 4. Kinds of materials and finishes.
 - 5. Descriptive names of equipment.

6. Modifications and options to standard equipment required by the contract.
 7. Leave blank area, size approximately 4 by 2-1/2 inches, near title block (for Engineer's stamp imprint).
 8. In order to facilitate review of shop drawings, they shall be noted, indicating by cross-reference the contract drawings, notes, and specification paragraph numbers where items occur in the contract documents.
 9. See specific sections of specifications for further requirements.
- O. Technical Data: Submit technical data verifying that the item submitted complies with the requirements of the specifications. Technical data shall include manufacturer's name and model number, dimensions, weights, electrical characteristics, and clearances required. Indicate optional equipment and changes from the standard item as called for in the specifications. Provide drawings, or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.
- P. Same Manufacturer: In general, relays, contactors, starters, motor control centers, switchboards, panelboards, dry type transformers, disconnect switches, circuit breakers, manual motor starter switches, etc., shall be supplied and manufactured by the same manufacturer. This requirement shall apply to same type of electrical components specified in other Divisions.

2.3 EQUIPMENT, MATERIALS, AND SUPPORTS

- A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacture of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear the UL label.
- B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer, however, the methods shall not be less stringent than specified herein.
- C. Required Accessories: Provide all devices and materials, such as expansion bolts, foundation bolts, screws, channels, angles, and other attaching means, required to fasten enclosures, raceways, and other electrical equipment and materials to be mounted on structures which are existing or new.
- D. Protection: Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by the elements. Equipment shall be stored in dry permanent shelters. If apparatus has been damaged, such damage shall be repaired at no additional cost or time extension to the Contract. If apparatus has been subject to possible injury, it shall be thoroughly cleaned, dried out and put through tests as directed by the Manufacturer and Engineer, or shall be replaced, if directed by the Engineer, at no additional cost to the Contract. Provide temporary heating for equipment stored in unconditioned/unpowered space.

2.4 IDENTIFICATION OF EQUIPMENT

- A. General: Electrical items shall be identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system, which it serves or controls. Refer to Identification Section of the specifications for additional information.

2.5 CONCRETE PADS

- A. General: Provide reinforced concrete pads for floor mounted electrical equipment. Unless otherwise noted, pads shall be nominal four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by six (6) inches on all sides, except when equipment is flush against a wall, then the side or sides against the wall shall be flush with the equipment. Chamfer top edges 1/2". Trowel surfaces smooth. Reinforce pads with #5 reinforcing bars at 24" centers each way, unless specifically detailed on drawings.

2.6 SURFACE MOUNTED EQUIPMENT

- A. General: Surface mounted fixtures, outlets, cabinets, panels, etc. shall have a factory-applied finish or shall be painted as accepted by Engineer. Raceways and fittings, where allowed to be installed surface mounted, shall be painted to match the finish on which it was installed. Paint shall be in accordance with other applicable sections of these specifications.

2.7 CUTTING AND PATCHING

- A. Core Drilling: The Contractor shall be responsible for core drilling as required for work under this section, but in no case shall the Contractor cut into or weld onto any structural element of the project without the written approval of the Architect.
- B. Cutting and Patching: Cutting, rough patching and finish patching shall be provided as specified in the contract documents. Cutting and patching shall be performed in a neat and workmanlike manner. Upon completion, the patched area shall match adjacent surfaces.
- C. Openings and Sleeves: Locate openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.
- D. Roof Penetration: Provide roofer with pitch pans, fittings, etc., required for electrical items which penetrate the roof. Roof penetrations are to be waterproofed in such a manner that roofing guarantees are fully in force. Roof penetrations shall be coordinated with other Trades to ensure that roof warranty is not invalidated.

2.8 SLEEVES AND FORMS FOR OPENINGS

- A. Sleeves: Provide sleeves for raceways penetrating floors, walls, partitions, etc. Locate necessary slots for electrical work and form before concrete is poured. Refer to specification 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling" for additional requirements.
- B. Forms: Provide boxed out forms for raceway penetrations only where allowed by the Architect. Fill opening after raceway installation, with equivalent material.

2.9 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. General: Thoroughly instruct the Owner's Representative, to the complete satisfaction of the Architect and Engineer, in the proper operation of all systems and equipment provided. The Contractor shall make all arrangements, via the Architect, as to whom the instructions are to be given in the operation of the systems and the period of time in which they are to be given. The Architect shall be completely satisfied that the Owner's Representative has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by the Contractor to the Owner's Representative, then the Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the Specification has been complied with.
- B. Submittals: Submit to the Architect for approval five (5) typed sets, bound neatly in loose-leaf binders, of instructions for the installation, operation, care and maintenance of equipment and systems, including instructions for the ordering and stocking of spare parts for equipment installed under this contract. The lists shall include part number and suggested suppliers. Each set shall also include an itemized list of component parts that should be kept on hand and where such parts can be purchased.
- C. Information Requirements: Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section shall be clearly divided from the other sections. A sub index for each section shall also be provided.
- D. Instructions: The instructions shall contain information deemed necessary by the Architect and include but not limited to the following:
 - 1. Introduction:
 - a. Explanation of Manual and its use.
 - b. Summary description of the Electrical Systems.
 - c. Purpose of systems.
 - 2. System:
 - a. Detailed description of all systems.
 - b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.
 - 3. Operations:
 - a. Complete detailed, step by step, sequential description of all phases of operation for all portions of the systems, including start up, shutdown and balancing. Include posted instruction charts.
 - 4. Maintenance:
 - a. Parts list and part numbers.
 - b. Maintenance and replacement charts and the Manufacturer's recommendations for preventive maintenance.
 - c. Trouble shooting charts for systems and components.
 - d. Instructions for testing each type of part.
 - e. Recommended list of on-hand spare parts.

- f. Complete calibration instructions for all parts and entire systems.
 - g. General and miscellaneous maintenance notes.
- 5. Manufacturer's Literature:
 - a. Complete listing for all parts.
 - b. Names, addresses and telephone numbers.
 - c. Care and operation.
 - d. All pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
 - e. Internal wiring diagrams and Engineering data sheets for all items and/or equipment furnished under each Contract.
 - f. Guarantee and warranty data.

2.10 TEMPORARY LIGHT AND POWER

- A. Capacity: Provide capacity from new temporary service or from existing service. Make arrangements with the Owner for temporary service and pay all related expenses. Temporary light and power shall be provided constantly during the project dependent upon Owner's safety requirements.
- B. Lighting: Temporary light shall be based on one 200 watt lamp covering each 1,000 square foot of floor area in the building. Each room 100 square foot and over shall have a minimum of one 100-watt lamp with guards. Provide power for motors up to 3/4 horsepower only. Provisions are to be made for electric welders, if required.
- C. Outlets: Provide outlets located at convenient points so that extension cords of not over fifty (50) feet will reach work requiring artificial light or power.
- D. Other Connections: Contractors of other trades shall furnish their own cords and sockets, as may be required for their work and shall also pay for cost of temporary wiring of construction offices and shanties used by them.
- E. New Fixtures: Permanently installed lighting fixtures may be used for temporary lighting at the Contractor's option with the provision that cool white lamps for fluorescent, clear lamps for incandescent and marked temporary for other types shall be installed. At job completion, lamps shall be replaced with permanent lamps specified.
- F. Wiring: Temporary electrical work shall be furnished and installed in conformity with the National Electrical Code and in accordance with the requirements of the local ordinances and shall be maintained in a workmanlike manner throughout their entire construction period and shall be removed after installation of the permanent electrical systems. Extension cords shall be GFCI protected or shall be fed from GFCI circuit breakers.
- G. Payment: The contractor shall coordinate and discuss the cost of energy consumed by all trades with the owner. Incorporate decision--energy costs by owner or contractor--into a written statement included with GM.

2.11 EXISTING CONDITIONS

- A. Support: Existing Raceway and cables within the area of renovation shall be provided with proper supports as specified for new work in other sections of this specification.
- B. Installation: Existing electrical which is designated for reworking or requires relocation, repair or adjustment shall conform to applicable codes and shall be treated as new work complying to all sections of this specification.
- C. Violations: Where existing conditions are discovered which are not in compliance with the codes and standards, the Contractor shall submit proper documentation to the Architect for clarification and corrective work direction. Existing conditions shall not remain which will create a disapproval of the renovated area.
- D. Patching: Existing Raceway and cable penetrations shall be properly fire treated per code and specification requirements. The Contractor shall thoroughly inspect existing locations and include the cost of patching and repair in his proposed construction cost.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.
- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function, conforming to applicable standards of building system construction, and exhibiting a high degree of quality and proficiency which is judged by the Architect as equivalent as or better than that ordinarily produced by qualified industry tradesmen.
- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment who, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship and not acceptable to the Architect, shall be removed and reinstalled by qualified craftsmen, at no change in the contract price.

3.2 PROTECTION AND CLEAN UP

- A. Protection and Restoration: Suitably protect equipment provided under this Division during construction. Restore damaged surfaces and items to "like new" condition before a request for substantial completion inspection.
- B. Handling: Materials shall be properly protected and Raceway openings shall be temporarily closed by the Contractor to prevent obstruction and damage. Post notice prohibiting the use of systems provided under this Contract, prior to completion of work and acceptance of systems by the Owner's representative. The Contractor shall take precautions to protect his materials from damage and theft.

- C. Safeguards: The Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or systems provided under this contract.
- D. Cleanup: Keep the job site free from debris and rubbish. Remove debris and rubbish from the site and leave premises in clean condition on a daily basis.

3.3 SYSTEMS GUARANTEE

- A. General: Provide a one-year guarantee. This guarantee shall be by the Contractor to the Owner for any defective workmanship or material, which has been provided under this Contract at no cost to the Owner for a period of one year from the date of substantial completion of the System. The guarantee shall include lamps, for ninety days after date of Substantial Completion of the System. Explain the provisions of guarantee to the Owner at the "Demonstration of Completed System".

3.4 FINAL OBSERVATION

- A. General: Work shall be completed, and forms and other information shall be submitted for acceptance one week prior to the request for final observation of the installation.

3.5 SPECIAL CONSIDERATIONS

- A. Comply with special requirements imposed at site by Owner. This may include badging of employees, prohibition of smoking, special working hours, or special working conditions.

END OF SECTION 260010

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping and conduit installed at required slope.
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- C. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- D. Cut sleeves to length for mounting flush with both surfaces of walls.
- E. Extend sleeves installed in floors 2 inches above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

SECTION 26 05 01 – TESTS AND PERFORMANCE VERIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified in this section.

1.2 DESCRIPTION

- A. Time: Perform verification work as required to show that the System is operating correctly in accordance with contract documents and manufacturer's literature. All verification shall be done after 3-day full operational period.
- B. Submission: Submit check out memos and completed testing results of all systems, cable, equipment, devices, etc., for acceptance prior to being energized or utilized.

1.3 QUALITY ASSURANCE

- A. Compliance: Testing shall comply to the following standards;
 - 1. NEMA
 - 2. ASTM
 - 3. NETA
 - 4. ANSI C2
 - 5. ICEA
 - 6. NFPA

PART 2 - TESTS

2.1 EQUIPMENT

- A. Instruments: Supply all instruments required to read and record data. Calibration date shall be submitted on test reports. All instruments shall be certified per NETA standards.
- B. Adjustments: Adjust system to operate at the required performance levels and within all tolerances as required by NETA Standards.

2.2 APPLICATIONS

- A. Switchboards, Panelboards and Mechanical Equipment Feeders: After feeders are in place, but before being connected to devices and equipment, test for shorts, opens, and for intentional and unintentional grounds.

- B. Cables 600 Volts or Less: Cables 600 volts or less in size #1/0 and larger shall be meggered using an industry approved "megger" with 1000V internal generating voltage. Readings shall be recorded and submitted to the Engineer for acceptance prior to energizing same. If values are less than recommended NETA values notify Engineer. Submit 5 copies of tabulated megger test values for all cables.
- C. Main circuit breakers and feeder circuit breakers 200 amps and greater shall be tested using primary injection testing as per NETA Specifications. Reports to be submitted as substantial completion shall include manufacturer's time current curve number and trip time.
 - 1. On-site injection testing with AHJ shall be provided for both the building main service and generator service breakers. Refer to section 26 24 13 for additional requirements.
- D. Infrared Scanning: After Substantial Completion—but not more than 60 days after Final Acceptance—perform an infrared scan in accordance with NETA standards on all switchgear, substations, panelboards, enclosed circuit breakers, fused disconnects, motor control centers, (30A or larger) non-fused disconnects, (30A or larger) junction boxes, and splices with conductors No. 3 AWG or larger. Include all applicable components within each piece of equipment. Remove box and equipment covers so splices/busses/lugs are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice/equipment 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies equipment and splices checked that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action. This report shall be part submitted as part of the contract closeout documents.

2.3 MOTORS

- A. Procedure: Test run each motor, (5 HP) and larger. Tabulate and submit electronic copies of the Test Information at substantial completion for final inspection. Refer to form at the end of this Section.
- B. Provisions: With the system energized, line-to-line voltage and line current measurements shall be made at the motors under full load conditions. The condition shall be corrected when measured values deviate plus or minus 10% from the nameplate ratings.

- C. Insulation: Test the insulation resistance's of all motor windings to ground with an appropriate test instrument as recommended by the motor manufacturer, before applying line voltage to the motors. If these values are less than the manufacturer's recommended values, notify the contractor providing the motor for correction before initial start-up.
- D. Power Factor: Check power factor of all motors (5 HP) and larger while driving it's intended load, and at all operating speeds.

2.4 Grounds

- A. Electrode Ground: The resistance of electrodes (main service, generators, transformer, etc.) shall not exceed 5 ohms and shall be measured by The Contractor before equipment is placed in operation. Testing shall be performed on all grounding electrode installations. Testing shall be 2 point method in accordance with IEEE Standard 81. Submit all ground test readings to the Engineer in tabulated format at substantial completion.

2.5 EQUIPOTENTIAL GROUND TESTING & OTHER RECEPTACLE TESTING

- A. Equipotential Ground: Test all metal conductive surfaces likely to become energized within all patient care areas. Test all large conductive surfaces likely to become energized within a volume defined as 6 foot from the patient bed horizontally or 7 foot 6 inches vertically from the floor.
1. Large metal surfaces not likely to be energized, which do not require testing:
 - a. Window frames
 - b. Door frames
 - c. Floor drains
 - d. Moveable metal cabinets
 2. Small wall-mounted conductive surfaces not likely to become energized, which do not require testing:
 - a. Surface-mounted towel
 - b. Soap dispensers
 - c. Mirrors
 3. Reference Point. The voltage and impedance measurements shall be taken with respect to a reference point, which shall be one of the following:
 - a. Grounding point, in or near the room under test, that is electrically remote from receptacles (e.g., an all-metal cold-water pipe)

- b. Grounding contact of a receptacle that is powered from a different ATS (automatic transfer switch) from the receptacle under test.
- 4. Test Method:
 - a. Utilize an established ground bus or ground bar in panel serving area.
 - b. Measure voltage from reference point to conductive surfaces and all receptacle ground contacts. Neither reference nor testing points shall be live during test.
 - c. Measure impedance between reference point and receptacle ground contacts.
 - d. Identify the reference ground for each room on the ground test report. Provide a blue dot label with a permanent adhesive backing located on the bottom center of the reference ground outlet cover.
- 5. Equipotential Grounding Maximum Acceptable Values:
 - a. Voltage: 20 mV plus or minus 20 percent.
 - b. Impedance: 0.1 ohm plus or minus 20 percent
 - c. If values are found to be above this range, installation shall be examined, troubleshooted, and fixed until the acceptable values are obtained.
- 6. Equipment:
 - a. Impedance Hampden MVO-1-PB. No exceptions. This device can be rented. Provide unit with fresh batteries prior to commencing initial tests. Meter shall be certified to have been calibrated within 12 months of the testing date. Ground wire extensions cannot be used or attached to this device.
- 7. Ground Test Report. Complete ground test report included at the end of this specification section and make available copies of such to engineer and inspecting authority at final inspection.
- B. Receptacle Testing: Test all receptacles within project area (new or existing). Record results.
 - a. The physical integrity of each receptacle shall be confirmed by visual inspection.
 - b. The continuity of the grounding circuit in each electrical receptacle shall be verified.
 - c. Correct polarity of the hot and neutral connections in each electrical receptacle shall be confirmed via polarity tester.

- d. The retention force of the grounding blade of each electrical receptacle (except locking-type receptacles) shall be not less than 115 g (4 oz).
- e. Prior to energizing circuitry, test wiring devices for electrical continuity, and for short circuits. Once energized use receptacle tester to check for open/reversed wires.

2.6 GROUND-FAULT PROTECTION TESTING

- 1. When equipment ground-fault protection is first installed, each level shall be performance-tested. Test shall use the Ground fault pick-up and delay values found on the coordination study.

2.7 LINE ISOLATION MONITOR TESTS

- A. Where isolated power systems are installed, the line isolation monitor (LIM) circuit shall be tested after installation, and prior to being placed in service, by successively grounding each line of the energized distribution system through a resistor whose value is $200 \times V$ (ohms), where V equals measured line voltage. The visual and audible alarms shall be activated.

2.8 DRY TYPE TRANSFORMERS

- 1. Required Factory Tests: Required factory tests shall be as follows;
 - 2. Ratio
 - 3. Polarity
 - 4. Losses:
 - (1) No load
 - (2) Full load
 - 5. Resistance Measurements
 - 6. Impedance
 - 7. Temperature
 - 8. Impulse Strength
 - 9. Sound Level
 - 10. Exciting Current

11. Low-frequency Dielectric Strength

12. ANSI Point and Curve

B. Submission: Submit test results with shop drawings

2.9 EMERGENCY SYSTEM

A. General: Submit emergency system tests in accordance with NFPA 110. Refer to Specification Section 26 23 13, 263213 and 263600 and for additional testing information.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Equipotential Ground Test Report: Complete report form at the end of this specification.
- B. Cable Test Report: Submit Cable Test Report in electronic form.
- C. Check Out Memos: Complete all information on forms at the end of this specification, project information, and certificate of completed demonstration memo. Submit data for examination and acceptance prior to final inspection request.
- D. Tabulated Data: Submit data in electronic form with names of the personnel who performed the test.
- E. Final: Submit accepted memos before a request for final inspection.

3.2 QUANTITIES

- A. Quantity: Submit check-out memo in electronic form for each major item of equipment. Insert accepted memos in each brochure with the performance verification information and submittal data.

END OF SECTION

FACILITY NAME: _____ PROJECT NAME: _____ .

DATE: _____ TESTED BY: _____

MAXIMUM TEST INTERVALS:

NAME:

GENERAL CARE - 12 MOS.

CRITICAL CARE - 6 MOS.

COMPANY:

WET LOCATIONS - 12 MOS.

GROUND TEST REPORT

TYPE METER USED AND EXTERNAL NETWORK IF USED:

NOTE: MAXIMUM READINGS PERMITTED - 20 MV NEW CONSTRUCTION

0.1 OHM NEW CONSTRUCTION

Room No.	AREA TYPE Description (C) = CRITICAL CARE AREA (G) = GENERAL CARE AREA	VOLTAGE MEASUREMENT			IMPEDANCE MEASUREMENT		REMARKS - IF VOLTAGE READINGS MORE THAN 20MV IN EXISTING CONST. NOTE TESTS & INVESTIGATION REQUIRED.
		NO. OF RECEPT S.	NO. OF OTHE R	MAX. READING IN MILIVOLT S	NO. OF RECEPT S.	MAX READING IN OHMS	

PROJECT NAME: _____

MOTOR TEST INFORMATION

Name of Checker: _____

Date Checked: _____

- (a) Name and identifying mark of motor _____
- (b) Manufacturer _____
- (c) Model Number _____
- (d) Serial Number _____
- (e) RPM _____
- (f) Frame Size _____
- (g) Code Letter _____
- (h) Horsepower _____
- (i) Nameplate Voltage and Phase _____
- (j) Nameplate Amps _____
- (k) Actual Voltage _____
- (l) Actual Amps _____
- (m) Starter Manufacturer _____
- (n) Starter Size _____
- (o) Heater Size, Catalog No. and Amp Rating _____
- (p) Manufacturer of dual-element fuse _____
- (q) Amp rating of fuse _____
- (r) Power Factor at _____ Speed _____
(For variable speed motors provide
recording chart over operating range)

TABULATED DATA

VOLTAGE AND AMPERAGE READINGS

SWITCHGEAR OR PANELBOARD

FULL LOAD AMPERAGE READINGS:

DATE

TIME

PHASE A.

B.

C.

N.

FULL LOAD VOLTAGE READINGS:

DATE

TIME

PHASE	A TO N _____	A TO B
	B TO N _____	A TO C
	C TO N _____	B TO C

NO LOAD VOLTAGE READINGS

DATE

TIME

PHASE	A TO N _____	A TO B
	B TO N _____	A TO C
	C TO N _____	B TO C

_____ENGINEERS REPRESENTATIVE

_____CONTRACTORS REPRESENTATIVE

SECTION 260519 – LOW VOLTAGE ELECTRICAL POWER & CONDUCTORS & CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Copper building wires and cables rated 600 V and less
2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Record Documents:

1. Indicate all feeder types, sizes, & lengths on the record drawings riser diagrams.

1.6 QUALITY ASSURANCE

- A. Manufacturers shall be regularly engaged in the manufacture of wire systems and fittings of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years in the USA

- B. Compliance: Materials shall comply with the following codes and standards, current edition as adopted by the Authority Having Jurisdiction, as they apply to the different wire types specified herein.

1. UL:

- a. 44 – Thermoset-Insulated Wire and Cables
- b. 83 – Thermoplastic-Insulated Wires and Cables
- c. 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors
- d. 486B – Wire Connectors for Use with Aluminum Conductors
- e. 486C – Splicing Wire Connections
- f. 493 – Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
- g. 514 – Standard for Fittings for Cable and Conduit
- h. 854 – Service Entrance Cables
- i. 1479 – Through Penetration Fire Rating (HCF MC Cable)
- j. 1569 – Metal Clad Cables

- k. 1581 – Standard for Reference Standard for Electrical Wires, Cables, and Flexible Cords
- 2. National Electric Code NFPA-70 (2014 edition)
- 3. Insulated Cable Engineers Association (ICEA)
- C. Testing Agency Qualifications: Member company of NETA or an NRTL. Testing Agency's Field Supervisor shall be certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. Alpha Wire.
 - 3. Belden Inc.
 - 4. General Cable Technologies Corporation.
 - 5. Southwire Incorporated.
- B. Conductor Material: Copper
- C. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- D. Conductor Insulation:
 - 1. Comply with NEMA WC 70/ICEA S-95-658 & UL 83 for Type THHN & THWN-2.
 - 2. Comply with NEMA WC 70/ICEA S-95-658 & UL 44 for Type XHHW-2.
- E. Multiconductor Cables: Provide the following type(s) of cables in NEC approved locations and applications where indicated. Provide cable UL listed for particular application:
 - 1. Healthcare Grade Metal-Clad Cable: Type MC:
 - a. Complete with ground conductor.
 - b. Approved for use in Health Care Facilities patient areas – Type HCF MC - AP.
 - 2. Portable Cord: Type SO.
- F. If no size is shown, wire shall be #12 AWG, except that branch homeruns" over 100 ft. in length shall be #10 AWG for 120/208V circuits, and homeruns over 200' in length shall be #10 AWG for 277/480V circuits.
- G. All wiring shall be manufactured in the USA and of 98 percent conductivity.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Gardner Bender.
 - 3. Hubbell Power Systems, Inc.
 - 4. Ideal Industries, Inc.
 - 5. O-Z/Gedney; a brand of the EGS Electrical Group.
 - 6. 3M; Electrical Markets Division.
 - 7. Tyco Electronics.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70 (2014 edition).

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- D. General: Install electrical cables, conductors and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
 - 1. Install all conductors within raceways or approved cables.
 - 2. Install conductors and cables run under the building slab in raceways.
 - 3. Install minimum No. 12 AWG for circuits 100 volts and above.
 - 4. Increase conductor size as required due to NEC derating requirements and availability. Minimum conductor sizes, based upon NEC Ampacity Table 310.15 (B) (16), (310.16 for NEC prior to 2014) and maximum 40 percent conduit raceway fill, are shown on Drawings. Generally use 60 deg. C ratings below 100 amperes and 75 deg. C rating above 100 amperes. If conductor size increased, be responsible for associated conduit size, based upon NEC Ampacity Tables and maximum 40 percent conduit raceway fill, and increased ground conductor size per NEC. If raceway type altered, also be

responsible for associated conduit raceway size per NEC to meet 40 percent maximum fill.

5. Keep conductor splices to a minimum.
6. Do not bend conductors and cables, either permanently or temporarily during installation to radii less than that recommended by the manufacturer.
7. Provide slack wire for all future connections with ends of wires taped and blank box covers installed.
8. Provide conductors of the same size from the protective device to the last load.
9. Make conductor length identical for parallel feeders.
10. Ground and continuously polarize systems properly throughout following the color coding specified.
11. Support conductors in vertical raceways. One cable support shall be provided at the top or as close to the top as practical, plus a support for each additional interval of spacing per NEC.
12. Install exposed cable parallel and perpendicular to surfaces, or exposed structural members, and following surface contours, where possible.
13. Support cables according to Division 26 Sections "Hangers and Supports."

B. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. When conductors larger than No. 12 AWG are installed on 15 – 20-A circuits, splice No. 12 AWG pigtails for device connections.

C. Dedicated Branch Circuit Neutrals:

1. Provide dedicated neutrals for all branch circuits.

D. Coordinate conductor and cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires and cables with other work.

1. Pull conductors simultaneously where more than one is being installed in same raceway.

2. Use of pull compound or lubricant is to be avoided unless absolutely necessary and other reduced cable tension pulling methods exhausted; compound used must not deteriorate conductor or insulation, and be one of the following:
 - a. Ideal-Aqua-Gel.
 - b. Polywater.
 - c. Yellow 77.
 3. Use of pull compound or lubricant shall not be permitted for wiring associated with Isolated Power Systems.
 4. Use pulling means including lubricated conductor jackets, fish tape, cable, rope and basket weave wire and cable grips which will not damage cables or raceway.
- E. Use type XHHW-2 insulation with appropriate NEC derating factors when wiring is within seven feet of passing over or attached to the following:
1. Boilers and other heat producing equipment.
 2. Hot water heaters.
 3. Rooftop (no derating required here).
 4. Exposed exterior locations.

3.2 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch circuits & feeders serving motors, major UPS systems, & imaging equipment: Copper

3.3 CONDUCTOR APPLICATIONS

- A. General: Provide wire and cable suitable for the temperature, conditions and location where indicated.
- B. Install UL Type THWN-2 or THHN wiring in conduit, for branch circuits #10 and smaller except where noted elsewhere in the specification or the drawings.
 1. Include wet location label when installed in underground or above grade exterior raceways.
- C. Install UL Type XHHW-2 or THHN wiring in conduit, for feeders and branch circuits #8 and larger except where noted elsewhere in the specification or the drawings.
 1. Include wet location label when installed in underground or above grade exterior raceways.
- D. Install UL Type XHHW-2 wiring in conduit, for feeders and branch circuits installed outside of the building envelope, in raceway in contact with soil, or whenever raceway may be subject to moisture and/or condensation.

- E. Install SO hard service cord with stainless steel, wire mesh, strain relief at terminations to suit application.
- F. If no size is shown, wire shall be #12 AWG, except that as follows:
 - 1. Branch homeruns over 100 ft. in length shall be #10 AWG for 120/208V circuits, and homeruns over 200' in length shall be #10 AWG for 277/480V circuits.
 - 2. All IT (Information Technology)/IDF (Intermediate Distribution Frame) /MDF (Main Distribution Frame)/MER (Main Equipment/Entrance Room) Rooms shall have wiring with minimum #10 AWG for all circuits. Also match conductor amperage ratings with special receptacle amperage rating at minimum.
 - 3. All outside circuits shall be minimum #10 AWG wiring.

3.4 EQUIPMENT CONNECTIONS

- A. Follow circuit numbers shown on Drawings in connecting circuits to panelboards. In the event that field observation shows that the indicated circuit numbers are not connected to the corresponding panel overcurrent device, make all corrections necessary. Each branch circuit homerun containing two or more circuits with a common neutral shall be connected to the circuit breaker or switch in a three- or four-wire branch circuit panelboard so that no two of the circuits will be fed from the same phase.
- B. Provide all wiring to and between motors, controllers, line voltage (120-600 volt) control devices, disconnect switches, and other related electrical equipment, except where such items are factory wired.
- C. Terminate power wiring for elevator systems at the respective controller, and be in compliance with the manufacturer's approved shop drawings.
- D. Provide power and all wiring connections to the control devices for electrically operated overhead doors, door operators and control devices which will be provided under another division.
- E. Connectors for Splices, Taps, and Terminations:
 - 1. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connector and terminals to comply with tightening torques specified in UL Std. 486A and B.
 - 2. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings that unspliced conductors.
 - a. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
 - 3. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

4. Make splices and taps in wiring No. 10 AWG and smaller mechanically and electrically secure with mechanical pressure type splicing devices.
5. Make splices and taps of conductors No. 8 AWG or larger and all splices in motor terminal boxes using compression connectors requiring the use of compression tools for securing the conductors in the connectors. Termination of conductors at all distribution equipment, except transformers, shall be made using mechanical lugs. Connectors shall be of high conductivity, corrosion-resistant material and have actual contact area that shall provide at least the current carrying capacity of the wire or cable. For conductors No. 1/0 and larger, connector lugs shall be of the two-hole type. Connector lugs shall be bolted to bussing using Belleville washers in combination with flat washers and nuts. Compression connectors shall be as manufactured by Thomas & Betts, Burndy, or approved equal.
6. Each conductor lug or bus connection shall be individually made with separate lug and/or bolt as required for the termination.
7. Provide insulated connectors for splices and taps with a self-fusing rubber insulating tape that is non-corrosive to the connector and the conductor. Insulation tape shall have a minimum of 350 volts per mil dielectric strength. Friction or vinyl tape shall be applied directly over rubber insulating tape equal to 3M Scotch 88 type.

3.5 HOSPITAL GRADE METAL-CLAD CABLE (HCF MCAP TYPE MCCABLE)

- A. May be used only when approved by the local authority having jurisdiction.
- B. In general, may be used only for branch circuits serving lighting and convenience outlet wiring, and only for those branches and areas which are not identified herein as exceptions.
- C. The exception branches and areas where Hospital Grade MC Cable is not acceptable for lighting and convenience outlet wiring are as follows:
 1. Any critical branch circuit.
 2. Any life safety branch circuits.
 3. Any equipment branch circuits.
 4. Diagnostic/therapeutic equipment (x-ray, etc.).
 5. Emergency branch circuit.
 6. Exposed locations.
 7. Exterior circuits.
 8. Hazardous locations.
 9. Isolated power branch circuits.
 10. Mechanical, electrical, battery and boilerrooms.
 11. Sitework.
 12. Through fire and smoke barriers.
 13. Wet and damp locations.
 14. Emergency systems (NEC 700).
 15. Legally required standby systems (NEC 701).
 16. Optional standby systems (NEC 702).

- D. Hospital Grade MC cable shall be secured at intervals not exceeding 6 feet and within 12 inches of every outlet box or fitting. Cable should be neatly organized for its entire run.
- E. All luminaire whips shall be HCF cabling or hard pipe conduit such as EMT. Refer to specification 26 05 33 raceways and boxes for electrical systems for permitted hard pipe conduits. Where HCF is used, the whip shall not exceed 6 total feet in length. No fixture-to-fixture whips—also known as daisy-chaining—are permitted. All luminaire whips in OR's, Cath/EP Labs, Cysto's, and all other places where isolation power is used on the project shall be hard pipe conduit.
- F. No flex cable (including HCF) of any kind is permitted above hard ceilings; hard piping shall be per type per specification 26 05 33.
- G. At all terminations, a fitting shall be provided to protect the conductors from abrasion. Approved insulating bushings shall be provided between the conductors and the armor. The connector or clamp by which the cable is fastened to boxes or cabinets shall be metal, UL approved for use with Hospital Grade MC cable, and of such design that the insulating bushing will be visible for inspection. Internal box cable clamps are not acceptable.
- H. Metal-clad cable for use in Health Care Facilities shall be UL listed and labeled by Underwriters Laboratories as Metal-Clad – All Purpose (MC-AP). The cable shall contain an insulated green copper grounding conductor which is factory installed, along with color coded circuit conductors and a separate bonding wire. The assembly shall be protected by interlocked aluminum armor painted green and shall provide redundant, dual path grounding. Cable shall meet the redundant grounding requirements of National Electrical Code Article 517.
- I. Any zip ties used for HCF cabling shall be plenum rated.

3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- B. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Refer to specification section “26 05 00 Tests and Performance Verification” for additional tests & inspections.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified in this section

1.2 BONDING AND EQUIPMENT GROUNDING

- A. Description of System: In general, all electrical equipment (metallic conduit, motor frames, panelboards, etc.) shall be bonded together with a green insulated copper system grounding conductor in accordance with specific rules of Article 250 of the NEC Equipment grounding conductors through the raceway system shall be continuous from main switch ground bus to panel ground bar of each panelboard, and from panel grounding bar of each panelboard to branch circuit equipment and devices.
- B. Equipment Grounding Conductors: All raceways shall have an insulated copper system ground conductor run throughout the entire length of circuit installed within conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill when determining conduit sizes, even though not included or shown on drawings.
- C. Redundant Grounding: In general, all feeder circuits that serve enclosed circuit breakers or panels located in exam/procedure/control rooms as well as any and all branch circuits shall be provided with a redundant grounding system through the use of grounding conductors and metallic conduit.
- D. Bonding: Provide bonding of the equipment grounding terminal busses of normal and essential branch circuit panelboards serving the same area with a continuous #10 AWG copper green insulated conductor, in compliance with NEC 517-14.
- E. Bushings: Provide insulated grounding bushings on all metallic feeder conduits terminated within panelboards, switchboards or enclosed overcurrent devices. Provide insulated grounding bushings on all branch circuit conduits where concentric knockouts are used.
- F. Connection to Other Systems: Provide all required grounding and bonding connections as specified herein and as required by the National Electrical Code.
- G. Provide insulated bonding jumpers for installed medical equipment as required for equipotential grounding within the patient vicinity of patient care areas.

1.3 SUBMITTALS

- A. General: Submit product data for each type of product indicated including ground rods, ground wire, ground connectors, ground bars, and data on exothermic welds.

1.4 QUALITY ASSURANCE

- A. Compliance: The entire ground system shall meet or exceed the minimum requirements NEC 250 and IEEE Std. 142 (green book).
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 GROUNDING ELECTRODE AND BONDING CONDUCTORS

- A. General: Except as specified in C below, provide UL and NEC approved types of copper with THWN, THHN, or XHHW with green insulation or green tape on black insulation the entire length of conductor not in conduit.
- B. Size: Grounding electrode conductors shall be sized as specified herein and on the drawings, but in no case shall be smaller than required by NEC 250.
- C. Insulation: Conductors above ground shall be insulated, conductors run below grade shall be bare.

2.2 CONNECTIONS

- A. Bonding: One piece mechanical lugs or wire terminals, properly sized and approved by the local authority having jurisdiction shall be used to bond ground wires together or to junction boxes and panel cabinets.
- B. Permanent Bonding: All connections and bonds made underground and to building steel shall be exothermic weld type-connections.

2.3 GROUND BAR

- A. Description & Locations: Refer to ground bar details on drawings
- B. Interconnections: All interconnections sized #3/0 and larger shall be installed with irreversible lugs. Mechanical lugs are not permitted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation: Equipment grounding conductors shall be installed as follows:
 - 1. Shall be installed in metal conduit, with both conductor and conduit shall be bonded at each end.
 - 2. Have connections accessible for inspection and made with approved solderless connectors brazed (or bolted) to the equipment or structure to be grounded.
 - 3. Shall in NO case be a current carrying conductor.
 - 4. Have green insulation.

- B. Bushings: Bond all grounding bushings to the equipment ground bus of the panel or switchboard, or overcurrent device in which it is located. Bond shall be made via an insulated bonding conductor of same size as equipment ground conductor run in the circuit.

3.2 TESTING

- A. Testing: Provide testing as required in other sections of this specification, including but not limited to sections 260100 and 260500.
- B. Reports: Submit impedance test reports for all separately derived services to the Engineer prior to project completion.

3.3 CONNECTIONS

- A. Preparation: All contact surfaces shall be thoroughly cleaned before connections are made, to ensure good metal to metal contact.

END OF SECTION 260526

SECTION 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. Fabco Plastics Wholesale Limited.
 - d. Seasafe, Inc.
 - 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 3. Fitting and Accessory Materials: Same as channels and angles.
 - 4. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

- D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03.
- C. Anchor equipment to concrete base.
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 – RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Surface raceways.
 - 6. Boxes, enclosures, and cabinets.
 - 7. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. GRC: Galvanized rigid steel conduit.
- F. IMC: Intermediate metal conduit.
- G. LFMC: Liquidtight flexible metal conduit.
- H. LFNC: Liquidtight flexible nonmetallic conduit.
- I. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: All major feeders/conduit routes shall be shown in coordinated shop drawings for review and approval prior to install.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, include those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.
 - 4. Electri-Flex Company.
 - 5. O-Z/Gedney; a brand of EGS Electrical Group.
 - 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 - 7. Republic Conduit.
 - 8. Robroy Industries.
 - 9. Southwire Company.
 - 10. Thomas & Betts Corporation.
 - 11. LeGrand
 - 12. Western Tube and Conduit Corporation.
 - 13. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; Zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B. Match raceway material.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 2. Fittings for EMT: Steel, compression or setscrew type. Only two-screw kinds are permitted.
 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- l. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.
 6. Condux International, Inc.
 7. Electri-Flex Company.
 8. Kraloy.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Niedax-Kleinhuis USA, Inc.
 11. RACO; a Hubbell company.
 12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. LFNC: Comply with UL 1660.
- F. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Fittings for LFNC: Comply with UL 514B.
- H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. Cooper B-Line, Inc.
 2. Hoffman; a Pentair company.
 3. Mono-Systems, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. NEMA 250 Type 3R aluminum.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mono-Systems, Inc.
 - b. Panduit Corp.
 - c. Wiremold / Legrand.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's

standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems Division.
 - b. Mono-Systems, Inc.
 - c. Panduit Corp.
 - d. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Technologies Company; Cooper Crouse-Hinds.
 2. EGS/Appleton Electric.
 3. Hoffman; a Pentair company.
 4. Hubbell Incorporated; Killark Division.
 5. O-Z/Gedney; a brand of EGS Electrical Group.
 6. RACO; a Hubbell Company.
 7. Robroy Industries.
 8. Spring City Electrical Manufacturing Company.
 9. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 10. Thomas & Betts Corporation.
 11. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:

1. Material: Cast metal.
 2. Type: Fully adjustable.
 3. Shape: Rectangular.
 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Nonmetallic Floor Boxes: Nonadjustable, round.
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- N. Gangable boxes are prohibited.
- O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic.
 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- P. Cabinets:
1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation; Hubbell Power Systems.
 - d. New Basis.
 - e. Oldcastle Precast, Inc.; Christy Concrete Products.
 - f. Synertech Moulded Products; a division of Oldcastle Precast, Inc.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, as indicated for each service.

7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATIONS

- A. Outdoors aboveground (apply raceway products as specified below unless otherwise indicated):
 1. Exposed/Concealed locations: GRC
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit on the site: RNC, Type EPC-80-PVC direct buried.
 4. Underslab Conduit in Patient Care Areas: PVC coated RMC or RMC with bitumastic.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 6. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed inside electrical rooms and IT rooms: EMT.
 2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 4. Damp or Wet Locations: GRC.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.

- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. A. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from RNC to GRC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- V. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings/couplings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- AA. Locate boxes so that cover or plate will not span different building finishes.
- BB. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

- DD. Set metal floor boxes level and flush with finished floor surface.
- EE. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Division 26 Section "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 26 05 33.29 WALL AND CEILING RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and Division 01 – General Requirements apply.

1.2 SECTION INCLUDES

- A. Surface mounted/recessed wall and ceiling raceway system for imaging rooms, including X-Ray & CT Rooms

1.3 RELATED SECTIONS

- A. Division 26 - Electrical: Electrical systems and components.
- B. Section 26 05 33.36 Trenchduct Feeder System
- C. Division 27 - Communications: Communications systems and components.

1.4 SUBMITTALS

- A. Product Data: Submit for wall and ceiling raceway system and components.
- B. Shop Drawings: For wall and ceiling raceway system and components. Include plans, elevations, sections, details, and attachments to other work.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms regularly engaged in manufacture of wall and ceiling raceway system and components of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide wall and ceiling raceway components produced by a manufacturer listed in this section.
- B. Electrical Raceways and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to wall and ceiling raceway system and components. Comply with UL 5 and cUL 5 "Standard for Surface Metal Raceways and Fittings" and NFPA 70, Articles 300 and 660. Listed and labeled by UL and Canadian Underwriters Laboratories (cUL).

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver wall and ceiling raceway system and associated components in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. Basis-of-Design Product: The design for wall and ceiling raceway system and associated components is based on the Wiremold® WallDuct® Medical Raceway System manufactured by legrand/Wiremold, 60 Woodlawn Street, West Hartford, CT 06110; toll-free 800-621-0049, telephone 860-233-6251, fax 860-232-2062; Web Site: www.legrand.us/wiremold.
- B. Substitutions will be considered under provisions of Section 01 25 00.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards. Locate duct in strict accordance with Drawings in order to maintain electrical module spacing. Remove any burrs or sharp edges on material.
- B. Mount ducts by means of screws or other fasteners acceptable to manufacturer of ducts to securely mount the system. Mounting devices shall attach through the back or sides of the body. Exposed threads are not permitted inside the raceway.
- C. Assemble the ducts and fittings using coupling angles and screws provided with the ducts. Install angles and screws on inside of body using pre-punched holes.
- D. Field cut straight lengths to fit project conditions.
- E. Field drill holes in body to match coupling angle holes with #20 drill (.161-inch diameter). Install screws provided from inside body.
- F. Maximum wire fill capacity shall not exceed 40 percent of the interior cross sectional area of the duct.
- G. Mechanical Security: Duct systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
- H. Accessories: Provide accessories as required for a complete installation.
- I. Provide as many dividers as needed to properly separate cables based on class & voltage ratings as required by NEC.

END OF SECTION 260533.29

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeve coordination and installation.
2. Sleeves for raceways and cables.
3. Watertight sleeve seals.

1.2 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene-monomer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.3 COORDINATION

- A. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- C. Cut and patch for sleeve installations. Coordinate with work of other trades.
- D. Coordinate sleeves with cable installer(s).
- E. Coordinate with cable installer to ensure cables are rigidly supported on both sides of the floor or wall assembly.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 26 Section "Basic Division 26 Requirements."

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination drawing depicting sleeve locations.

PART 2 - PRODUCTS

2.1 SLEEVES FOR CABLES

- A. Steel Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3 or 3.5-mm) thickness as indicated and of length to suit application.

2.2 WATERTIGHT SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of two subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
- 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
- 3. Pressure Plates: Plastic . Include two for each sealing element.
- 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Install sleeves, conduits, and cables with required clearance spaces allowing proper installation of wall and sealing materials. At no time exceed the outside diameter of the sleeve conduit or cables penetrating barriers by more than 2 inch or less than 1/4 inch for all penetrations of barriers. If access openings are required in raceway, install 24 inch minimum lengths of runs between access openings and point of entry into barriers. Perform all patching of barriers as required. Patch with materials compatible with barrier construction and fire resistant rating equal to, or greater than, the barrier rating.
- B. Coordinate firestopping at all raceways and cables passing through floor structures and interior walls noted as fire resistant rated barriers, and interior walls noted as smoke barriers.
- C. Coordinate rating of smoke and fire barriers where electrical boxes, cabinet, or equipment is installed within using firestopping pads or foam.

3.2 SLEEVES INSTALLATION FOR CABLE PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- B. Aggregate cross-sectional area of cable(s) shall be maximum 45 percent of the associated opening or sleeve.
- C. Installed bushed metallic raceway or cable having metallic armor where passing through one hour-fire rated vertical barriers.
- D. Install bushed rigid steel raceway sleeve where cables are passing through two hour or more fire rated vertical barriers.
- E. Install only bushed rigid steel raceway where passing through floors or horizontal fire barriers except where cable is totally enclosed in a fire resistant rated shaft.
- F. Concrete Slabs and Walls: Install cast iron sleeves for penetrations unless core drilled holes or formed openings are used in concrete slabs and walls. Install watertight sleeves during erection of slabs and walls.
- G. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- H. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - 2. For sleeve rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
- I. Cut sleeves to length for mounting flush with both wall surfaces 2 inches per side for bushings.

- J. Provide minimum clearance space of 2 inches from opening to all adjacent raceways, ducts, pipes, sleeves, etc., when penetrating barriers.
- K. Provide after-set sleeves at all concrete floor penetrations to extend up above floor 2 inches when a penetration is required of an existing slab condition. Core drill hole 1/2 inch diameter less than sleeve size. Core drill larger hole partway thru floor slab to allow sleeve to sit in place. Provide tight pack dry grout fill in core cut all round sleeve and provide gun applied sealant all around with sloped finish. Pack fire safing insulation all around raceway and provide 3/4 inch deep gun applied sealant all around at top of penetration.
- L. Size pipe sleeves to provide 1/4 inch (6.4 mm) annular clear space between cables and between sleeve and cable unless sleeve seal is to be installed.
- M. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- N. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth and location of joint according to Division 07 Section "Joint Sealants."

3.3 WATERTIGHT SLEEVE SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

SECTION 260553 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified of this section.
- B. 26 05 73 19 arc-flash hazard analysis. Provide and apply arc-flash labels according to 26 05 73 19. If no arc-flash hazard analysis is required by project, then apply generic arc flash sticker to all panelboards, distribution boards, switchboards, switchgear.

1.2 DESCRIPTION

- A. Extent: Electrical identification work as required by the Contract Documents or other specifications.
- B. Types: Electrical identification work specified in the Contract Documents include the following;
 - 1. Electrical power, control, and communication conductors.
 - 2. Operational instructions and warnings.
 - 3. Danger signs.
 - 4. Conduits, boxes, etc.
 - 5. Distribution Equipment.
 - 6. Cabinets.
 - 7. Equipment/system identification signs and tags.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacturer of electrical identification products of types required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.
- C. UL Compliance: Comply with applicable requirements of UL Standard 969, "Marking and Labeling Systems", pertaining to electrical identification systems.
- D. ANSI Compliance: Comply with applicable requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems", and ANSI Standard Z53.1 "Color Designation."
- E. NEMA Compliance: Comply with applicable requirements of NEMA Standard No's. WC-1 and WC-2 pertaining to identification of power and control conductors.
- F. ADA Compliance: All signage shall meet ADA standards. Identification for maintenance purposes shall be as specified herein.

1.4 SUBMITTALS

- A. General: Submit shop drawings of all identification materials to be used for this project. Submit one sample of each item with the shop drawings.
- B.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SUPPLIERS OR MANUFACTURERS

- A. General: Subject to compliance with requirements, manufacturers offering electrical identification products which may be incorporated in the work include, but not limited to, the following:
 - 1. Alarm Supply Co, Inc.
 - 2. Direct Safety Co.
 - 3. Ideal Industries, Inc.
 - 4. LEM Products, Inc.
 - 5. Markal Company
 - 6. National Band and Tag Co.
 - 7. Panduit Corp.
 - 8. Seton Name Plate Co.
 - 9. Thomas and Betts Co.
 - 10. Carlton Industries, Inc.

2.2 LANGUAGE

- A. General: Provide all products in this section in English.

2.3 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than one single type is specified for an application, selection shall be at the installer's option, however, provide a single selection for each application.
- B. Voltage Marking: Except as otherwise indicated, provide lettering which indicates voltage of the conductor(s) in conduit. Provide 4 inch minimum length with 7/8 inch minimum lettering for 2 inch and smaller conduit. Provide 8 inch minimum length with 1-1/4 inch minimum lettering for larger than 2 inch conduit. Provide one marker for each 20' section of conduit. Color shall match system printing requirements.
- C. Plasticized Tags: Manufacturer's standard preprinted or partially preprinted accident prevention and operation tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4 x 5-5/8 inch, with brass grommets and wire fasteners, and with appropriate pre-printed wording including large size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

- D. Baked Enamel Danger Signs: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20 gauge steel; of standard red, black and white graphics; 14 x 10 inch size except where 10 x 7 inch is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, and subsequent directive e.g. HIGH VOLTAGE, KEEP OUT; BURIED CABLE, DO NOT DIG; LIVE PARTS, DO NOT TOUCH SWITCH.
- E. Engraved Plastic Laminate Nameplates: Provide engraving phenolic plastic laminate, minimum 1/16 inch thick, engraved with square standard pica lettering and wording as specified herein. Provide beveled edge in order to eliminate sharp corners. Provide contact type permanent adhesive for adhering nameplate to the substrate. Adhesive nameplate shall be permanently installed. Titles shall be 1/2 inch high and all other lettering shall be 1/4 inch high.
- F. Underground Type Plastic Line Marker: Manufacturer's standard permanent, bright colored, continuous printed, metal backed plastic tape, intended for direct burial service; not less than 6 inches wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service or type of buried cable.
- G. Junction (or Pull) Box Identification: Provide neat indelible felt tip, stenciled marking on junction box and pullbox covers indicating panel and circuit numbers contained in the box. Letter sizes shall be 1 inch high minimum. Provide non-stenciled markings inside the junction box and on the exterior edge to match the cover markings. Paint/mark junction box with branch power color.
- H.

2.4 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations, and other designations used in electrical identification work, with corresponding designations specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by the manufacturer and as required for proper identification and operation/maintenance of the electrical system equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.
- B. Size: System identification labeling consists of providing minimum 1/2 inch high stenciled black letters for raceway systems.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Installation: Install electrical identification products as indicated, in accordance with manufacturer's written instructions, as required by the NEC and as specified herein.
- 1. Sequence: If identification is applied to surfaces that require finish, install identification after completing finish work.
- B. Coordination: Where identification is to be applied to surfaces which require a field finish application, install identification after completion of such application.

- C. Regulations: Comply with governing regulations and requests of governing authorities for the identification of electrical work.
- D. Hazards: Identify all rooms, spaces, and equipment that house potential electrical hazards, and label with appropriate signage or indicators.

3.2 RACEWAY SYSTEM IDENTIFICATION

- A. Identification: Identify all raceways provided or utilized as part of this project as follows;
 - 1. Apply bands 10 feet on center along the raceway system and at each side of walls or floors, and at branches from mains.
 - 2. Identify the following services:

Service

- a. Low Voltage
- b. High Voltage
- c. Fire Alarm
- d. Nurse Call
- e. EES/Gen/Emerg. Dist.
 - (1) Life Safety
 - (2) Critical Branch
 - (3) Critical UPS Branch
 - (4) Equipment Branch

Emergency

Critical Branch
Critical UPS Branch
Equipment Branch

120/208

277/480

Life Saf

3.3 CABLE/CONDUCTOR IDENTIFICATION

- A. General: Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where conductors of more than one circuit or communication (such as color coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for the project's electrical work.

3.4 OPERATIONAL IDENTIFICATION AND WARNINGS

- A. General: Provide identification and warning wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems. Provide identification and warning identification if necessary for signage to help prevent misuse of electrical facilities by unauthorized personnel.
- B. Plasticized signs: Install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes.

- C. Locations: In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified as constituting dangers for persons in or about the project.
- D. High Voltage: Install danger signs wherever it is practicable, for persons to come into contact with electrical power of voltages higher than 277 volts to ground.
- E. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.
- F. Electrical Equipment Rooms: Provide warning signage at the entrance to each such room; identify the hazard, and direct non-qualified personnel to stay away.
- G. Equipment/Device Labels:
 - 1. Nameplates: Install an engraved colored phenolic plastic laminate nameplate on each unit of electrical equipment in the building, including central or master unit of each electrical system. Provide text matching terminology and numbering of the contract documents and shop drawings. Except as otherwise indicated, each nameplate shall provide at minimum four lines of text:
 - (1)
 - (2) First line shall state the name of the equipment,
 - (3) The second line shall state the voltage, phase (1 or 3), and # (typically 3 or 4) wire system
 - (4) The third line shall state the panel and circuit number(s)
 - (5) The fourth line shall state the branch of power.
 - 2.
 - 3. Locations: Provide nameplates for each unit of the following categories of electrical work:
 - a. Switchboard, panelboards, electrical cabinets, and enclosures.
 - (1) Provide a nameplate outside above the door (if equipped with one)
- (2) For the main service entrance(s), provide additional nameplates with the available short circuit amperes per the final short circuit study.
 - b. Access panel/doors to electrical facilities.
 - c. Major electrical switchboards.
 - d. Electrical Substations.
 - e. Power Transfer Equipment.
 - f. Transformers
 - g. Generators
 - h. Motor starters.
 - i. Disconnect switches.
 - j. Enclosed circuit breakers.
 - k.
 - l. Light switch cover plate -
 - (1) Provide 3/16 inch engraved and "filled in" lettering indicating panelboard and circuit number "where fed from" for all light switches, including low voltage & momentary switches. Refer to wiring devices spec for material & color info.

- (2) Division 26 Contractor shall be responsible for the engraving of all O.F.C.I. medical headwall and medical articulating arm/boom unit coverplates (receptacles, light switches, etc.). Contractor shall be responsible for obtaining coverplates from Owner's vendor in ample time to adhere to the project schedule.
 - m. Receptacle Coverplate -
 - (1) Provide 3/16 inch engraved and "filled in" lettering indicating panelboard and circuit number "where fed from" for all receptacles. Refer to wiring devices spec for material & color info
 - (2) Division 26 Contractor shall be responsible for the engraving of all O.F.C.I. medical headwall and medical articulating arm/boom unit coverplates (receptacles, light switches, etc.). Contractor shall be responsible for obtaining coverplates from Owner's vendor in ample time to adhere to the project schedule.
 - n. Communication Control Panels, Terminal Cabinets and Equipment Cabinets.
 - o. Remote Annunciators
 - p. Circuit breakers on distribution, switchgear, and switchboards
 - q. Fire alarm panels
 - r. BMS/BAS control panels
 - s. All vendor panels in IT rooms, including security, H.U.G.S, etc
 - t. Other similar equipment as designated by the Engineer.
4. Viewing: Install nameplates at locations indicated and where not otherwise indicated at a location for the best convenience of viewing without interference with operation and maintenance of equipment.
- a. Secure to substrate with rigid fasteners. Utilize adhesive where fasteners cannot penetrate substrate.
 - b.
 - c. Designate branch of electrical power system (i.e. Normal, Life Safety, Critical, or Equipment branch) on nameplate along with Equipment designation.
5. Names: The names or wording used for a particular machine shall be the same as the one used on all motor starters, disconnects and remote button stations nameplates for that machine.
6. Label Submittal: Provide submittal to engineer prior to ordering showing all planned nameplates (except coverplates). It's recommended if possible that this submittal be submitted when the project is roughly 80% complete.

END OF SECTION 260553

SECTION 260573.13 – SHORT CIRCUIT STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related specifications: 260573.19 Arc-Flash Hazard Analysis, 230515 Variable Frequency Drives. If the requirements in one of the related specifications conflict with this submittal, proceed with the most stringent requirement.
- C. 26 06 53 identification of electrical systems: Provide and apply available fault current labels where indicated in 26 06 53.

1.2 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- G. SCCR: Short-circuit current rating.
- H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

- A. Special Consideration is required by the contractor for an expedited delivery of this submittal to the engineer along with any subsequent revised/resubmitted submittals as no electrical equipment shall be released to manufacture without an approved short circuit study.
- B. Product Data:
 - 1. For computer software program to be used for studies.
 - 2. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - a. Short-circuit study input data, including completed computer program input data sheets.
 - b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - 1) Submit study report for action prior to receiving final approval of distribution equipment submittals.
 - 2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.
 - c. Official letterhead from the electric utility company showing percent impedance (%Z), maximum fault current currently at utility entrance location, and any future maximum fault current or other requirements the engineer must design to.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power System Analysis Specialist.
 - 2. For Field Adjusting Agency.

1.6 CLOSEOUT SUBMITTAL

- A. Operation and Maintenance Data:
 - 1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 - 2. The following are from the Short-Circuit Study Report:
 - a. Final one-line diagram.
 - b. Final Short-Circuit Study Report.
 - c. Short-circuit study data files.
 - d. Power system data.

3. Provide “For-Record” Short Circuit Study submittal at substantial completion with the following addressed/revised in the study:
 - a. Any previous comment(s) from an “approved as noted” submittal
 - b. Any changes arising from RFI/Submittal/Bulletins/ASI or other revisions
 - c. Any changes arising from equipment that was delivered on site that differs from the approved arc flash study.
 - d. Contractor shall include in their bid a final revised submittal with the above changes to be included at no additional cost to the owner. Contractor shall coordinate with and notify arc flash analysis specialist on any changes for final record study.

- B. Completed & approved power studies (including short-circuit, coordination, & arc flash studies) shall be turned over to owner & engineer in both PDF and SKM Power Tools file formats during record submittal.

1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Comply with IEEE 141, 399, and IEEE 551
- D. Manual calculations are not permitted.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 2. A member company of NETA.
 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Studies shall be performed using SKM Power Tools for Windows

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6. Derating factors and environmental conditions.
 - 7. Any revisions to electrical equipment required by the study.
- D. Code concerns, deficiencies, comments, and recommendations for system improvements or revisions shall be provided in the report in its own section. Contractor shall hold an allowance equal to 10% of the electrical distribution panelboard package or a minimum \$5,000, whichever is greater, to address these items. Examples for use of this allowance include providing a higher rating AIC panel/breakers, bigger wire sizes, and adding ground fault protection to breakers required by NEC. Only one total allowance as defined above is needed per power study package (which may or may not include all power studies including coordination, short circuit, and arc flash). Only one total allowance as defined above is needed per power study package (which may or may not include all power studies including coordination, short circuit, and arc flash).
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
6. Reach out to facility electrical utility company and obtain an up-to-date fault current letter. Include letter in report. Available fault current at utility entrance on short circuit report shall match or exceed this number.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.

- 3) Based on calculated symmetrical value multiplied by 2.7.
3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study via in-person field study or previous verified data.
 1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 3. For equipment that is existing to remain or existing to be relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.
- B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- F. Include the ac fault-current decay from chillers, induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- G. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- H. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION 260573.13

SECTION 260573.19 – ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related specifications: 260573.16 Coordination Studies, 260573.13 Short-Circuit Studies, 230515 Variable Frequency Drives. If the requirements in one of the related specifications conflict with this submittal, proceed with the most stringent requirement.

1.2 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- D. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- E. SCCR: Short-circuit current rating.
- F. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- G. Single-Line Diagram: See "One-Line Diagram."
- H. VCB: Vertical Electrodes in Metal Box
- I. VCCB: Vertical Electrodes in Metal Box (terminated in an insulated barrier)
- J. HCB: Horizontal Electrodes in Metal Box
- K. VOA: Vertical Electrodes in Open Air
- L. HOA: Horizontal Electrodes in Open Air

- M. Arc Flash Boundary: Distance where the incident energy equals 1.2 cal/cm²
- N. Working Distance: The distance between a person's face and chest area and a prospective arc source (Informational Note: The incident energy increases as the distance from the arc source decreases.)
- O. ARMS - Arc Flash Reduction Maintenance System – Button & system located on/nearby the overcurrent protection device (OCPD) that when activated will override OPD settings to have the OCPD act with no intentional time delay when tripping upon sensing a fault to reduce arc flash hazard.

1.4 ACTION SUBMITTALS

- A. Special Consideration is required by the contractor for an expedited delivery of this submittal to the engineer along with any subsequent revised/resubmitted submittals as no electrical equipment shall be released to manufacture without an approved power studies package (short circuit, coordination, and arc flash studies)
- B. Code concerns, deficiencies, comments, and recommendations for system improvements or revisions shall be provided in the report in its own section. Contractor shall hold an allowance equal to 10% of the electrical distribution panelboard package or a minimum \$5,000, whichever is greater, to address these items. Examples for use of this allowance include providing a higher rating AIC panel/breakers, bigger wire sizes, and adding ground fault protection to breakers required by NEC. Only one total allowance as defined above is needed per power study package (which may or may not include all power studies including coordination, short circuit, and arc flash).
- C. Product Data: For computer software program to be used for studies.
- D. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by Professional Engineer who is also a Power Systems Analysis Specialist.
 - 3. Submit study report for action prior to receiving final approval of distribution equipment submittals.
 - 4. Provide an example arc flash label in the report.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Provide "For-Record" Arc Flash Study submittal—which includes finalized versions of all previously submitted material & data—at substantial completion with the following addressed/revised in the study:

- a. Any previous comment(s) from an “approved as noted” submittal
 - b. Any changes arising from RFI/Submittal/Bulletins/ASI or other revisions
 - c. Any changes arising from equipment that was delivered on site that differs from the approved arc flash study.
 - d. Contractor shall include in their bid a final revised submittal with the above changes to be included at no additional cost to the owner. Contractor shall coordinate with and notify arc flash analysis specialist on any changes for final record study.
- B. Provide one-line and overall floor plan with record drawings showing location of all equipment used in the study. At each equipment that is part of the study, provide the following information:
1. Indicate arc-flash energy.
 2. Minimum Arc Rating of Clothing (in cal/cm²) with corresponding working distance and glove class
- C. Completed & approved power studies (including short-circuit, coordination, & arc flash studies) shall be turned over to owner & engineer in both PDF and SKM Power Tools file formats during record submittal.

1.6 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Manual calculations are unacceptable.
- C. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by a Power Systems Analysis Specialist.
- E. Field Adjusting Agency Qualifications:
 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 2. A member company of NETA.
 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. SKM Power*Tools (no exceptions)

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths as confirmed installed by the contractor at end of project as well as any other field information required to complete this study.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
 - 1. There will be an output report for each of the following scenarios:
 - a. *Main Report* - Utilities On/Generator On/ATS's switched to Utility/Normal Power. Arc flash stickers shall be based on these results and values. ARMS off.
 - b. *Generator Report* - Utilities Off/Generator Off/ATS's switched to Generator/backup power. ARMS off.
 - c. *ARMS On Report (Normal Power)* - Utilities On/Generator On/ATS's switched to Utility/Normal Power.
 - d. *ARMS On Report (Generator Power)* - On (Generator Power) - Utilities Off/Generator Off/ATS's switched to Generator/backup power

2. For each scenario, show the following for each equipment location included in the report:
 - a. Bus/Equipment Name.
 - b. Location designation.
 - c. Fed from Bus/Equipment Name.
 - d. Voltage (V or kV)
 - e. Equipment Class (as defined by IEEE 1584-2018: 15kV switchgear, 15kV MCC, 5kV Switchgear Big/Small, 5kV MCC, Low-Voltage Switchgear, Shallow Low-Voltage MCC & Panelboards, Deep Low-Voltage MCCs and Panelboards, Cable Junction Box Shallow/Typical)
 - f. Enclosure Size Correction Factors (as defined by IEEE 1584-2018: electrode configuration: VCB, VCBB, HCB, VOA, HOA; typical vs shallow for gear <600V)
 - g. Arc Gap (mm)
 - h. Bolted Fault (kA)
 - i. Estimated Arc Fault (kA)
 - j. Arcing Time (sec)
 - k. Estimated Arc Flash Boundary (ft)
 - l. Working Distance (inches) of Incident Energy
 - m. Incident Energy (cal/cm²)
 - n. Minimum Arc Rating of Clothing (in cal/cm²) with corresponding working distance
 - o. Glove class.
 - H. Fault study input data, case descriptions, initial voltage range (as defined by IEEE 1584-2018 – 600V, 2700V, 15000V) before interpolation, and fault-current calculations including a definition of terms.
 - I. Front and rear access equipment shall be given two calculations and stickers, one for the front and one for the rear. The different working distance of both sides shall be considered.
- 2.3 ARC-FLASH WARNING LABELS
- A. Comply with additional requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
 - B. Labels.

1. Label shall match existing facility standards and format as much as practically possible. If previous format does not match latest IEEE 1584-2018 standards, previous facility label shall be discarded for that described below.
2. Labels shall be applied by contractor prior to Owner's occupancy of the building and/or renovation.
3. Format of label shall be approved by owner & engineer during submittal process.
4. Label Colors:
 - a. Labels shall have an orange header with the wording "WARNING" for all equipment with incident energy below 40 cal/cm².
 - b. Labels shall have a red header with the wording "DANGER" for all equipment with incident energy at or above 40 cal/cm².
 - c. The second line (white background) shall read "Arc Flash and Shock Hazard".
 - d. The third line (white background) "Appropriate PPE Required".
 - e. The fourth line (white background) "De-energize equipment prior to work being performed when possible"
 - f. The fifth line (white background) "Values are with utility on, generator off & ARMs off. Refer to report for other scenario values." OR "Values are with generator on (not connected to utility) and ARMS off. Refer to report for other scenario values."
 - g. The sixth line (white background) shall read:
 - 1) "Arc Flash calculations were completed using the Incident Energy Analysis Method per 2018 NFPA 70E Annex D.4. Refer to the Incident Energy listed on this label as well as Table 130.5(G) for appropriate PPE for working on this equipment while energized."
 - h. Last line in sticker (white background) shall read:
 - 1) "Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements"
5. Required Label Information: The rest of the sticker shall include the following information taken directly from the arc-flash hazard analysis:
 - a. Equipment name
 - b. Fed by
 - c. Nominal System Voltage
 - d. Arc Flash Boundary
 - e. Available Incident Energy in cal/cm²

- f. Corresponding Working Distance for Available Incident Energy
 - g. Engineering report number, revision number, engineering company name, and issue date.
- C. Labels shall be machine printed with no field-applied markings. All labels shall be high quality and water-resistant. Outside labels shall also be sun & weather-resistant. Labels shall be provided and installed by contractor.
- D. Apply one arc-flash label on the front cover of each section of the equipment for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.
- E. Each piece of equipment listed below shall have an arc-flash label applied to it:
 - 1. Motor-control center.
 - 2. Low-voltage switchboard.
 - 3. Switchgear.
 - 4. Medium-voltage switch.
 - 5. Medium-voltage switchgear
 - 6. Medium voltage transformers
 - 7. Low voltage transformers
 - 8. Low voltage distribution panels
 - 9. Low voltage panelboard
 - 10. Control panel.
 - 11. Enclosed circuit breaker, fusible and non-fusible safety switches
- F. Application of Warning Labels: Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist and commissioner.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Arc Flash Protection Studies shall be performed in conformance with the requirements of **IEEE 1584-2018 and NFPA 70E-2021**. When the requirements of either standard exceeds the other or this specification, the stricter requirement shall be used.
- B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis or obtain results from engineer. If obtained from engineer, both contractor and arc flash specialist shall obtain, sign, and return to engineer the arc flash file release form. If contractor/arc flash specialist is to perform short circuit and protective device coordination study, contractor/arc flash specialist shall obtain the following specification sections from engineer:
 - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
 - 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- E. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows (provide additional arc flash sticker and output report line for these circumstances):
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- F. Include any additional calculations needed to complete the arc flash label requirements and the arc flash final output report.

- G. Utility/Generator Scenarios: Arc Flash stickers shall show calculations with utility power on (generator power off) **unless the equipment is solely powered by the generator.** The final Arc-Flash Study Output Report shall be two studies:
1. One study with utility power on (generator power off)
 2. One study with all generator power on (utility power off)

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Engineer/Architect's attention.
 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584-2018 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Obtain electrical power utility impedance or available short circuit current at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus (three phase and line to ground).
 5. Full-load current of all loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

3.5 ADDITIONAL REQUIREMENTS

END OF SECTION 260573.19

SECTION 260923 – LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Standalone dimming controls
 - 2. Indoor occupancy and vacancy sensors.
 - 3. Lighting contactors.
- B. Related Requirements:
 - 1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
 - c. Dimming controls.
 - 2. Interconnection diagrams showing field-installed wiring.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control software.
 - b. Faulty operation of lighting control devices.
 - 2. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Leviton Manufacturing Co., Inc.
- B. General Requirements for Sensors:
 - 1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 - 2. Dual technology.
 - 3. Separate power pack.
 - 4. Hardwired connection to switch.
 - 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 7. Sensor Output: Sensor is powered from the power pack.
 - 8. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 9. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.

- b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 10. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 11. Bypass Switch: Override the "on" function in case of sensor failure.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.2 LIGHTING CONTACTORS

- A. Description: Electrically operated and electrically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including high in –rush LED Fixtures.
 - 2. Fault Current Withstand Rating: Equal to the panel that it's fed from.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- B. Interface with DDC System for HVAC: Provide hardware interface to enable the DDC system for HVAC to monitor and control lighting contactors.

2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. All cables above shall be installed in conduit according to 26 04 33 raceways and boxes for electrical systems.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

3.9 Additional Requirements

- A. Prior to lighting controls vendor being approved, the contractor shall coordinate a sit-down meeting with the owner for a live demo of all major parts of the proposed system, including programming. If a PC/laptop is recommended or required, vendor shall bring a laptop with them and walk owner through at least 1 programming of a single part using the laptop.
- B. If basis of design requires no central lighting control panel, equals can use a central lighting control panel as required. Contractor will be responsible for coordinating, locating, and powering any needed lighting controls panel at no additional cost to the owner.
- C. Confirm initial programming preferences of devices including occupancy sensors, programmable switches, timeclocks, etc. (i.e. timer for auto off function, status of occupancy sensor learning function enable/disable, schedule time on/off times of normal branch corridor lights, default device passwords, etc.) With owner prior to installing. All occupancy sensors shall be initially programmed for manual on/automatic off per ashrae 90.1 requirements.
- D. All occupancy sensors shall be dual technology.
- E. Provide all parts, pieces, & wiring needed for a complete operational system including items not shown on the lighting plans including power packs & lighting control panels as required by lighting vendor.
- F. Light switches that are shown on plan can and shall be modified to be digital, line voltage, momentary, etc. as required by the selected lighting controls system.
- G. Patient rooms shall not have any occupancy sensors nor photocells.
- H. If central lighting control panel(s) are used in final approved lighting control systems, relay lighting control schedules shall be submitted as a shop drawing by contractor.
- I. All normal branch lights in the corridors, lobbies and waiting areas shall be controlled by both local switches as shown on plans and a timeclock function.
- J. The lighting controls shop drawings submittal shall include project specific layout, wiring & riser diagrams, a master service agreement, and sequence of operation.
- K. Provide a training day at end of every phase of the project as well as two post occupancy training days: one at six months and one at one year after substantial completion of project. Each training session shall be planned for minimum 3 hours per major department.
- L. Life safety lighting circuits shall not be switched or dimmed unless specifically noted on plans. Provide UL924 relay for such lighting circuits.
- M. Provide minimum 1 programming dongle (such as USB to ethernet) to owner.

- N. Wifi systems are not permitted on lighting control systems.
- O. Label ceiling tile via p-tape where power pack or other lighting control system exists above the ceiling tile.

END OF SECTION 260923

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified of this section.

1.2 DESCRIPTION

- A. Description: Provide panelboards with main breaker or main lugs where shown on the drawings, of a dead front, distributed phase sequence design. Panelboards shall be equipped with thermal-magnetic molded case circuit breakers with frame and trip ratings as indicated in the schedules.

1.3 QUALITY ASSURANCE

- A. ANSI: the latest edition of the Reference Standards for the American National Standards Institute shall apply as follows;
 - 1. ANSI Y32.2 - Graphic Symbols for Electrical and Electronic Diagrams.
 - 2. ANSI Z55.1 - (R1973) Gray finishes for Industrial Apparatus and Equipment.
- B. NEMA: National Electrical Manufacturers Association shall apply as follows;
 - 1. NEMA PB1-1984 Panelboards
 - 2. NEMA PB1-57 Gutter space
- C. NFPA: The latest edition of the National Fire Protection Association shall apply as follows;
 - 1. NFPA-70 (2017) National Electrical Code.
- D. UL: The latest edition of the Underwriters' Laboratories, Incorporated shall apply as follows;
 - 1. UL Electrical Construction Materials List, panelboards-dead front type.
 - 2. UL 67 Panelboard wiring gutter space, bus heat rise test.
 - 3. UL 50 Cabinets - Rigidity and gauge of steel.
- E. Listing: Panelboards shall be listed by Underwriters Laboratories and bear the UL or other nationally recognized testing laboratory label. Where required, panelboards shall be listed for use as service entrance equipment.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product data shall be submitted on:
 - a. Panel

- b. Cabinet
- c. Bus
- d. Construction
- e. Dimensions

2. Shop drawings shall be submitted for every panel, and shall clearly indicate all of the following information:

- a. U.L. Label
- b. Each circuit breaker amperage rating, circuit number and position/location in panel
- c. Electrical characteristics of panel
- d. Main bus rating
- e. Main device rating
- f. Mounting type
- g. Dimensions, (width, depth, height, weight)
- h. Bus material
- i. Interrupting capacity of minimum rated breaker
- j. Panelboard classification
- k. Submit coordination curves on log-log paper for all breakers, fuses, transformers, etc.
- l. ½" = 1'0" electrical room plans per specification section 26 01 00-2.2.9.

1.5 COORDINATION STUDY

- A. Specified Manufacturers: All panelboards and circuit breakers shall be of the manufacturer and type specified herein, and as indicated on the drawings or the Coordination Study. Any discrepancies or conflicts in specified equipment shall be brought to the attention of the engineer during bid, for formal clarification.

1.6 OVERCURRENT PROTECTIVE DEVICES - DESCRIPTION

- A. Description of System: Connections of all items using electric power shall be included under this division of the specifications, including necessary wire, conduit, circuit protection, disconnects and accessories. Securing of roughing-in drawings and connection information for equipment involved shall also be included under this division. See other divisions for specifications for electrically operated equipment. Provide overcurrent protection for all wiring and equipment in accordance with the NEC, all federal, state and local codes as required and/or as shown on the drawings.

1.7 OVERCURRENT PROTECTIVE DEVICES - SUBMITTALS

- A. Shop drawings and product data: Shop drawings shall clearly indicate;
 - 1. Frame sizes and interrupting capacity of all circuit breakers.
 - 2. Horsepower ratings of rated voltage of circuit breakers.
 - 3. Device is U.L. Listed and bears the U.L. Label.
 - 4. Device complies with these specifications, drawings, and applicable standards of NEMA, IEEE, ANSI, and ASA.

PART 2 - PRODUCTS

2.1 PANELBOARDS

- A. Equipment: The panelboard bus assembly shall be enclosed in a steel cabinet and shall be surface or flush mounted as shown in the schedules. The box shall be fabricated from galvanized steel with standard baked enamel finish. Panelboard front shall include a door and shall have a flush, cylinder tumbler-type lock with catch and spring-loaded stainless steel door pull. All panelboard locks shall be keyed alike. All panel cabinets shall be a minimum of 20 inches wide. Fronts shall have adjustable indicating trim clamps which shall be completely concealed when the doors are closed. Doors shall be mounted with completely concealed steel hinges. Panel front shall not be removable with door in the locked position.
- B. Provide all panels with "Door-in-Door" feature to allow full access to the interior wiring compartment without the complete removal of the panel trim.
- C. Bus: Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as shown on the panelboard schedule. Bus shall be insulated and bus bar connections to the branch circuit breakers shall be of the "distributed phase" or phase sequence type. All current carrying parts of the bus structure shall be tin plated copper. A full size insulated neutral bus bar shall be provided. Provide system grounding tin plated copper bus bar bonded to the panelboard cabinet for connection of system grounding conductors. This bar shall be mechanically and electrically isolated from the neutral bar except where panelboard is used as service entrance equipment.
- D. Molded Case Circuit Breakers: All panelboard branch circuit breakers shall be plug-in style thermal-magnetic molded case type. Breakers shall be 1, 2 or 3 pole with an integral crossbar to assure simultaneous opening of all poles in multi-pole circuit breakers. Breakers shall have an overcenter, trip-free, toggle-type operating mechanism with quick-make, quick-break action and active handle indication. Handles shall have "ON", "OFF", and "TRIPPED" positions. Bolt-on circuit breakers shall be able to be installed in the panelboard without requiring additional mounting hardware.
- E. Solid State Circuit Breakers: Provide solid state circuit breakers for all breakers 125 amperes and above. Breakers shall have adjustable settings for long time pickup, long time delay, short-time pickup and short time delay. Refer to panel schedules and coordination study for exact circuit breaker requirements.
- F. 120/208 Rating: 120/208 volt circuit breakers shall have interrupting ratings a minimum of 10,000 rms symmetrical amperes at 240 volts AC maximum.
- G. 277/480 Rating: 277/480 volt circuit breakers shall have interrupting ratings a minimum of 14,000 rms symmetrical amperes minimum at 277 volts AC (single pole) or 480Y/277 volts AC 2 and 3 pole.
- H. Directories: A typed panelboard directory shall be provided for each panelboard and shall indicate the actual circuit number used, room name and type of load. Room names shall be the actual name or room number used not necessarily as shown on the drawing. Panel directories shall include all room numbers and names. Where panel schedules are indicated on the drawings as "receptacles or "lighting", etc., it shall be the responsibility of the Contractor to include the specific area served.

- I. Bracing: Panelboard as a complete unit shall be braced for a minimum short circuit rating equal to or greater than the lowest breaker symmetrical interrupting capacity as shown on the schedule. However, all panelboards shall be fully rated. No series ratings are allowed.
- J. Grounding: All panelboard cabinets shall have a system grounding bar bonded to the panelboard cabinet for connection of system grounding conductors. This bar shall be mechanically and electrically isolated from the neutral bar.
- K. Stubs: Provide four 3/4 inch conduits from all flush mounted panels to adjacent accessible ceiling space and mark "for future use". Provide pull cord in all empty conduits and provide plastic end bushing.
- L. All trip units on any adjustable breaker shall be visible and accessible to change trip unit settings without having to take any covers off that would expose a technician/electrician to a live bus.
- M. Provide higher rated bus as required to maintain 84 circuit panelboards as single-section.
- N. Provide higher rated bus as required where a specific design selection, such as Square D I-Line HCP-SU is called out, requires a minimum bus rating higher than what's shown on the drawings.
- O. All panelboards & distribution boards enclosures/busses/materials/etc. shall be full/maximum height.
- P. Load centers are not allowed.
- Q. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated aluminum.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
- R. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated aluminum.
 - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device as indicated on panel schedules.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device as indicated on panel schedules.
8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device as indicated on panel schedules.

- S. Design Basis: Square "D". Unless otherwise noted on the drawings, panelboard design selections shall be:

<u>120Y/208V</u>	<u>277Y/480V</u>
Below 300A: Square "D" NQOD Series	Below 300A: Square "D" NF Series
300A thru 1200A: Square "D": I-Line	300A thru 1200A Square "D": I-Line

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine area to receive panelboard and assure that there are adequate clearances to meet NEC requirements and normal maintenance issues.
- B. Correction: Start work only after any unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Provide panelboards in complete accordance with manufacturer's written instructions and all applicable codes.
- B. Support: Panelboards shall be rigidly supported and installed per manufacturers recommended supporting instructions, with beams provided if necessary, to suit actual site conditions. Panels shall not be directly mounted to masonry walls. Use kindorf or similar channel.
- C. Storage and Delivery: Panelboards shall be delivered to the site during that phase of panelboard installation in order to avoid storing panels on site where damage may occur. Replace any damaged parts prior to energizing panel. Cover panelboard to avoid damage to finish.

- D. Mounting: Do not mount equipment directly to masonry or concrete walls. Provide two uni-strut spacers between wall and panelboard.
- E. Connections: Tighten bus connections and mechanical fasteners. Clearly mark on the bus and bolt connections the location of manufacturer's required torque and torque amount. Use of a black indelible marker on the bus bar is permitted.
- F. Operations and Maintenance Data: Manufacturer's instructions for tightening bus connections, cleaning, operation and maintenance.
- G. After circuit breaker trip settings are set in field, the contractor shall install a zip tie to all trip unit covers to limit accessibility.

3.3 QUALITY CONTROL

- A. General: Field test prior to energization;
 - 1. Megger check, and record all data, of phase to phase and phase to ground insulation levels.
 - 2. Continuity.
 - 3. Proper phase relationship.

3.4 CHECK-OUT MEMO

- A. General: Submit check-out memo from panelboard representative.

3.5 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
- B. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
- C. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Panelboards will be considered defective if they do not pass tests and inspections.

- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.

3.7 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards or prior to central heating being provided in the space with panels, apply temporary heat to maintain temperature according to manufacturer's recommendations and/or written instructions.

END OF SECTION 262416

SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.2 DESCRIPTION

- A. General: Provide factory fabricated wiring devices in type, color and electrical rating for the service indicated to provide convenient access to the electrical system for portable and permanent connections, and control of fixed outlets.
- B. Ratings: Voltage and ampere rating of switches and receptacles shall be marked on the device, and shall conform to Voltage and Ampacity of system to which applied.
- C. Hardware: Devices consist of all the necessary hardware to complete an installation and provide a margin of safety by inaccessibility of live electrical components.

1.3 WALL DIMMING CONTROLS

- A. General: LED - Provide 0-10V dimming controls as indicated on drawings, and as specified herein to provide complete method of controlling the artificial illumination intensity portion of the project indicated. Provide dimmers, dimming wires, controls, interfaces, power packs and ancillary equipment, to make a complete dimming system.
- B. Standards: Voltage and ampere rating of dimmer controls shall be marked on dimmer, and shall conform to voltage of system to which applied.
 - 1. WD-2-1970 for dimmers.
 - 2. ANSI/IEEE Standard C62.41-1980
 - a. Test withstand voltage surges of up to 6000 Volts and current surges of up to 200 Amps for dimmers without damage.
 - 3. Nema WD-1
 - 4. UL 20
- C. Dimming Controls Quality Assurance:
 - 1. Manufacturers: Firms regularly engaged in manufacture of wiring devices, of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years. Fully test all dimmers for proper operation prior to shipment from the factory.
 - 2.
 - 3. Installer: A firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.
 - 4. Warranty: Provide a minimum one-year warranty from time of installation acceptance.

1.4 RECEPTACLES AND SWITCHES QUALITY ASSURANCE

- A. Manufacturers: Manufacturers shall be companies regularly engaged in manufacture of wiring devices, of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.
- C. Compliance: Comply with the latest edition of the following standards;
 - 1. NEMA WD1, WD3 and WD5
 - 2. UL 5, 20 and 231
 - 3. UL 498 Hospital Grade Receptacle (Straight Blade Only)
 - 4. UL 1449
 - 5. FEDERAL SPECIFICATIONS UL HOSPITAL GRADE ABRUPT REMOVAL TEST
 - 6.
 - a. Using cable and 10 pound weight.
 - 7.
 - 8. ANSI/IEEE Standard C62.41-1980 (Formerly IEEE 587)
 - a. Test withstand voltage surges of up to 6000 volts and current surges of up to 200 amperes without damage.
- D. Warranty: Provide a minimum one-year warranty from time of final acceptance.

1.5 SUBMITTALS

- A. Wiring Devices: Submit manufacturer's product data on all wiring devices listed on the drawings including;
 - 1. Colors
 - 2. Dimensions
 - 3. U.L. Label
 - 4. Finish
 - 5. Voltage
 - 6. Wiring diagrams
 - 7. Application information
- B.
- C. Coverplates and Identification: Submit type of identification used for coverplates to comply with the Identification Section as specified herein. Screws to match coverplate color.

1.6 SEQUENCING AND SCHEDULING

- A. Coordination: Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of all wiring devices.

PART 2 - PRODUCTS

2.1 DIMMING

- A. Color: Unless otherwise noted, standard device and matching faceplate color shall be as specified in other sections. Match colors with other devices, particularly when multi-gang application requires devices by other manufacturers.
- B. Dimensions: Profile projection off the wall of dimmer shall not exceed 0.295 inches beyond the surface of the wall. Dimmers in excess of 1500 watts shall not exceed 0.627 inches. Dimmer shall not exceed 2-3/4 inches in width for units 1000 watts or less and 4-1/2 inches for 1500 watt units. The height of all wattage units shall not exceed 4 1/2 inches. Depth of dimmer within backbox shall not exceed the following;
 - 1. 1-5/16 inches for units 1000 watts and lower.
 - 2. 1-5/8 inches for 1500 watt units.
 - 3. Selected low voltage and 2-location dimmers may exceed the above depth, but shall in no case exceed 1-11/16 inches.
 - 4. All dimmers within the same room or vicinity shall be of the same profile projection. Varying depths or projections shall not be tolerated.
- C. Mounting: Dimmers shall be mounted individually in a single gang standard switchbox, and be gangable without removing side sections (fins) or derating each unit's capacity.
- D. Operation: No auxiliary dimmers cabinets, control modules, or interfaces shall be required for operation at single location dimming of 2000 watts or less systems. 3-way dimmers shall be 3-way not one master and one slave.
- E. Rating: All devices shall be capable of operating at rated capacity indicated on the drawings without affecting rated lifetime.
- F. Temperature: Dimmers shall be capable of operating in an ambient temperature of 0 to 40 degrees C. (30 to 104 degrees F.)
- G. Static Discharge: Dimmers shall not be susceptible to damage or loss of memory due to static discharge.
- H. Short Circuit Test: Dimmers shall meet the UL 20 short circuit test requirement for snap switches.
- I. Filtering: Dimmers shall utilize an LC filtering network to minimize interference with properly installed radio, audio, and video equipment. Provide heavy duty toroidal choke to suppress RFI interference.
- J. Linear Slide Dimmers: Linear Slider Preset Systems Operation shall provide a continuous linear slider movement, which controls lighting intensity in direct proportion to the movement of the slider. Provide a smooth and continuous Square Law Dimming curve. Slider shall be of the dual wiping type, with a smooth movement, and an even pressure requirement for movement along the entire length of the slider. Encase the slider within the dimmer enclosure to prevent accumulation of dust on the control movement.

- K. Power-Failure Memory: When power is interrupted and subsequently returned, the lights shall come back on to the same levels set prior to the power interruption. Restoration to some other default or pre-set point is not acceptable, unless specifically noted elsewhere.
- L. Regulation: Regulate voltage so that a 10 percent variation in the line voltage shall cause no more than a 5 percent variation in the load voltage when the dimmer is operating at 40 volts (5 percent light output).
- M. Full-On Bypass: Dimmer shall contain latching contacts to bypass dimming circuitry when placed in the full on position to achieve 100 percent lighting output.
- N. LED Dimming: LED dimmers shall be rated at 120 volts or 277 volts as required.
 - 1. Operation: Dimming operation and performance shall be as follows;
 - a. Dimming range from 100 to 1 percent light output
 - b. Multi-LED fixture packs shall track evenly, with no perceptible difference in light levels for the same type lamps.
 - c. Different lengths of LED fixtures shall track evenly, with no perceptible difference in light levels for the same type of LED.
 - d. Fixture packs shall be inaudible with no apparent humming or buzzing at any point in the dimming range.
 - e. Warrantee does not become effective until after system is "seasoned" by 100 hour burning time.
 - 2. Electrical noise shall be suppressed to a level that shall not interfere with the normal operation of other properly designed and installed electrical equipment.
 - 3. Minimum light levels shall be user-adjustable in order to compensate for different loading of each dimmer.
 - 4. Use and interface control where necessary for preset systems, or for two location dimming of fluorescent fixtures.
- O. Dimmer Faceplates: Faceplates shall snap on to device with no visible means of attachment. Heat fins shall not be visible on front of device.
- P. Multigang: Using 2 or more dimmers and/or other wiring devices together. Include mounting frame for proper device alignment and faceplate attachment. Dimmers ganged with other devices in a common location shall be included under a single faceplate of the size and shape to accept all devices located in the ganged mounting. Utilize similar shaped wiring devices to dimmer configuration to keep alignment and appearance uniform.
- Q. Materials: Color and finish to be selected by the Architect/Engineer unless otherwise noted on the plans, or in these specifications.
- R. Dimmers shall be as that manufactured by Lutron Electronics Co., Hubbell Manufacturing Co., or Leviton Manufacturing.
 - 1. Design Selection: Lutron Nova Diva series.

2.2 CONVENIENCE RECEPTACLES

- A. In addition to the requirements below, all receptacles on this project shall be hospital grade and also be tamper-proof in pediatric rooms, lobbies, main corridors, and waiting rooms.
- B. Twenty Ampere Receptacles: Provide hospital grade single or duplex receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20 ampere, 120 volts, with metal plaster ears, side wiring, NEMA configuration 5-20R unless otherwise indicated.
- C. USB Charging Receptacles: Provide hospital grade duplex receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20 ampere, 120 volts, with metal plaster ears, side wiring, NEMA configuration 5-20R unless otherwise indicated. Device shall include (1) type A USB port and (1) type C USB port.
- D. Device Type: Unless otherwise noted, provide all receptacles as the duplex modular type.
- E. Construction: Heavy duty nylon face and wraparound mounting strap, locked into and on the body, utilizing heavy-gauge brass ground contacts riveted to strap. Include automatic self-grounding spring to assure ground continuity between mounting strap and metal wall box. T-slot one piece copper alloy contact wipes which interface with plug blades inserted at 3 points. Line terminals shall be screw terminals and accept #14 to #10 AWG copper conductors.
- F. Hospital Grade Receptacles shall have a green dot located on the face of the device, indicating compliance with the Fed Spec UL listed above.
- G. Ground Fault Circuit Interrupter: Provide hospital grade, duplex, ground fault circuit interrupter receptacles, grounding type, UL rated Class A, Group 1, 20 ampere ratings, 125 volts, 60 Hz; with solid state ground fault sensing and signaling; with 5 milliampere ground fault trip level; equipped with 20 ampere receptacle configuration, NEMA 5-20R. Device shall contain test and reset pushbuttons, with a visual display of the tripped position. All outside receptacles (weatherproof) shall be duplex G.F.C.I. type. Interrupter shall resist tripping from the effects of radio frequency (RF) signals from 10 to 450 MHz.
- H. Verify all outlet locations on the job prior to rough-in. Locations may be altered up to 6'-0" in any direction without additional cost to the Owner.
- I. Manufacturer: Manufacturer shall be Pass & Seymour, Leviton or Hubbell.

2.3 SWITCHES

- A. Toggle Switches: Provide specification grade, fast-make positive-break, flush single-pole, three and four way, silent operation toggle switches, 20 ampere, 120 volt AC or 277 volt AC as required, with mounting yoke insulated from mechanism, equipped with plaster ears, and side-wired screw terminals.

- B. Thermal Switch: Provide fractional horsepower switch with melting alloy type overload relay, with number of poles to coordinate with the equipment being controlled. Surface or flush mounted cover, as required, equipped with padlocking device and pilot light. Provide overload relay heaters for each pole of the switch, sized per the manufacturer's instruction, and adjust heater size to permit normal operation of the motor.

- C. Manufacturer: Manufacturer shall be Pass & Seymour, Leviton or Hubbell.

2.4 PLUGS AND CONNECTORS

- A. Standard: Comply with NEMA Standards Pub. No. WD1.

2.5 WIRING DEVICE ACCESSORIES

- A. Faceplates: Faceplates for interior outlets in "Medical Facilities", connected to normal or essential power supply system shall have type 302 stainless steel, 0.032 inch thick, non-magnetic, satin finish.
- B. Multigang: Provide all necessary hardware and frames to properly mount various devices in combinations.
- C. Weatherproof Device Covers: For all receptacles installed outdoors and/or in wet locations, provide a weatherproof enclosure in full compliance with NEC Article 406.8B. Enclosure shall be weatherproof, whether or not the attachment plug cap is inserted. Covers to be heavy duty diecast similar to Intermatic WP1010 series.

2.6 WIRING DEVICE & COVER PLATE COLORS

- A. Wiring devices—including low voltage light switches—color shall be as follows:
 - 1. Normal – Per drawings (Confirm with Owner & Architect prior to releasing to manufacture)
 - 2. Essential Electrical System (Includes Critical, Equipment, and Life Safety Branches) – Per drawings.
- B. Cover Plates
 - 1. Refer to electrical identification specification for cover plate requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

- A. General: Provide wiring devices, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Associations "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Completion: Delay installation of devices until wiring and wall finish is completed.
- C. Support: Devices shall be securely supported to box, not supported to device plate. Device shall trim out flush with front of plate. Do not support the device by loosening device mounting screws and attaching the coverplate for leveling.

- D. Adjustment: Provide receptacles and switches only in electrical boxes which are clean, free from excess building materials, debris, etc. Adjust devices to plumb when tightened, and in position to receive faceplate. Devices shall not be leveled by using the mounting screws, outlet boxes shall be flush to wall finish prevent leveling problems. Tighten devices and provide securely, so that there shall be no movement during usage.
- E. Position: Position ground pin at the top of the device in vertical application, unless otherwise noted.
- F. Wiring: Provide screw terminal connections using a single conductor only. Do not "back-stab" devices. Provide single whips for multiple conductor connections within each box.

3.2 WALL DIMMER INSTALLATION

- A. General: Provide dimmers in accordance with manufacturer's written application, wiring, and installation instructions. Applicable requirements of NEC and National Electrical Contractors Associations "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Mounting: Provide dimmers only in electrical boxes which are clean and free from excess building materials, debris, etc. Adjust dimmers to plumb when tightened, and in position to receive faceplate. Tighten dimmers so that there shall be no movement during usage.
- C. Cover Plates: Provide dimmers and cover plates in true vertical or horizontal alignment as applicable. Plates shall be properly secured by means of screws which have heads with finish matching the plate. Secure plates so as to maintain a snug fit against dimmer surfaces, with no gaps.

3.3 APPLICATION OF COVER PLATES

- A. Mounting: Provide coverplates in true vertical or horizontal alignment as applicable. Plates shall be properly secured by means of screws which have heads with finish matching the plate. Secure plates so as to maintain a snug fit against wall surfaces with no gaps.
- B. Replacement: Replace all coverplates which are warped, cracked, chipped, or whose color does not match the balance of the installation. Replace screws whose threads do not allow the drawing up tight of the coverplate to the device.

3.4 CLEANING

- A. Soiled Devices: Clean devices soiled prior to acceptance inspection, to remove all debris and foreign materials, such as paint, varnish, drywall compound, etc.
- B. Solutions: Do not use liquid cleaning solutions, etc. on the face of the devices without written direction from the Engineer/Architect.

3.5 TESTING

- A. Ground testing: Provide ground testing procedures as specified herein. Prior to energizing circuitry, test wiring devices for electrical continuity, and for short circuits.
- B. Polarity: Subsequent to energization, test wiring devices for proper polarity, and to demonstrate operations as required in this and other sections of this Specification.
- C. Recording: Record all tests as required in other sections of this specification.

END OF SECTION 262726

SECTION 262813 - FUSES

1 GENERAL

1. RELATED DOCUMENTS

- a. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

2. SUMMARY

- a. Section Includes:

- 1) Cartridge fuses rated 600-V ac and less for use in enclosed switches.
- 2) Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches.
- 3) Spare-fuse cabinets.

3. ACTION SUBMITTALS

- a. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

- 1) Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a) For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b) Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- 2) Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
- 3) Current-limitation curves for fuses with current-limiting characteristics.
- 4) Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse
- 5) Coordination charts and tables and related data.
- 6) Fuse sizes for elevator feeders and elevator disconnect switches.

4. CLOSEOUT SUBMITTALS

- a. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

- 1) Ambient temperature adjustment information.
- 2) Current-limitation curves for fuses with current-limiting characteristics.
- 3) Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

4)Coordination charts and tables and related data.

5.MAINTENANCE MATERIAL SUBMITTALS

a.Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1)Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

6.QUALITY ASSURANCE

a.Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

b.Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

c.Comply with NEMA FU 1 for cartridge fuses.

d.Comply with NFPA 70.

e.Comply with UL 248-11 for plug fuses.

7.PROJECT CONDITIONS

a.Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

8.COORDINATION

a.Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2PRODUCTS

1.MANUFACTURERS

a.Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1)Cooper Bussmann, Inc.
- 2)Ferraz Shawmut, Inc.
- 3)Littelfuse, Inc.

2.CARTRIDGE FUSES

a.Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

3.PLUG FUSES

- a.Characteristics: UL 248-11, nonrenewable plug fuses; 125-V ac.

4.PLUG-FUSE ADAPTERS

- a.Characteristics: Adapters for using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

5.SPARE-FUSE CABINET

- a.Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

- 1)Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
- 2)Finish: Gray, baked enamel.
- 3)Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
- 4)Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

3EXECUTION

1.EXAMINATION

- a.Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- b.Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- c.Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- d.Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- e.Proceed with installation only after unsatisfactory conditions have been corrected.

2.FUSE APPLICATIONS

- a.Cartridge Fuses:

- 1)Feeders: Class RK5, time delay.
- 2)Motor Branch Circuits: Class RK5, time delay.
- 3)Other Branch Circuits Class RK5, time delay.
- 4)Control Circuits: Class CC, fast acting.

3.INSTALLATION

- a.Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- b.Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

- c. Install spare-fuse cabinet(s).

4. IDENTIFICATION

- a. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 3000 feet.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis of Design: Square D
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

- A. Type HD, Heavy Duty:
 - 1. Single or double throw as indicated.
 - 2. Three pole.
 - 3. 600-V ac.
 - 4. 1200 A and smaller.
 - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
 - 6. Lockable handle with capability to accept three padlocks and interlocked with cover in closed position.
- B. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors, where indicated on drawings.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors, where indicated on drawings.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified, where indicated on drawings.

5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac, where indicated on drawings.
6. Hookstick Handle: Allows use of a hookstick to operate the handle, where indicated on drawings.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

- A. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Three Pole, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 1. Equipment Ground Kit: Where indicated on drawings, internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Where indicated on drawings, internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Where indicated on drawings, internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Where indicated on drawings, provides rejection of other fuse types when Class R fuses are specified.
 5. Hookstick Handle: Where indicated on drawings, allows use of a hookstick to operate the handle.
 6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.5 MOLDED-CASE CIRCUIT BREAKERS

- A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

- B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be fully rated per the fault current rating indicated on drawings.
- D. MCCBs shall be equipped with a device for locking in the isolated position.
- E. Lugs shall be suitable for 75 deg Celsius.
- F. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- H. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- I. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings, where indicated on drawings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- J. Current-Limiting Circuit Breakers: Where indicated on drawings, frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- K. Integrally Fused Circuit Breakers: Where indicated on drawings, thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- L. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Where indicated on drawings, single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- M. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: Where indicated on drawings, with Class B ground-fault protection (30-mA trip).
- N. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Where listed on drawings, appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Where listed on drawings, comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Where indicated on drawings, trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Where indicated on drawings, set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Key Interlock Kit: Where indicated on drawings, externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Zone-Selective Interlocking: Where indicated on drawings, integral with electronic [ground-fault] trip unit; for interlocking ground-fault protection function.
9. Electrical Operator: Where indicated on drawings, provide remote control for on, off, and reset operations.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the

circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: Where indicated on drawings, NEMA 250, Type 1.
 - 2. Outdoor Locations: Where indicated on drawings, NEMA 250, Type 3R or Type 4X as specified as noted.

3.3 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform tests and inspections.
- D. Tests and Inspections for Switches:
 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.

- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- E. Tests and Inspections for Molded Case Circuit Breakers:
1. Visual and Mechanical Inspection:
- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

- 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
 - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

- 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
- f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.
 1. Test procedures used.
 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges shall be set by contractor with the engineer of record's supervision per the engineer of record's direction.

END OF SECTION 262816

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.
 - 3. Reduced-voltage magnetic.
 - 4. Reduced-voltage solid state.
 - 5. Multispeed.
- B. Related Section:

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:
 - a. Each installed unit's type and details.

- b. Factory-installed devices.
 - c. Nameplate legends.
 - d. Short-circuit current rating of integrated unit.
 - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed controllers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.7 MATERIALS MAINTENANCE SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2010 m).

1.11 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Basis of Design: Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. Approved Equal: Square D

2.2 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 1. Configuration: Nonreversing.
 2. Surface mounting.
 3. Red pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 1. Configuration: Nonreversing.
 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 3. Surface mounting.
 4. Red pilot light.
- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 1. Configuration: Nonreversing.

2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
 3. Surface mounting.
 4. Red pilot light.
 5. N.O. auxiliary contact.
- E. Magnetic Controllers: Full voltage, across the line, electrically held.
1. Configuration: Nonreversing.
 2. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.
 5. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - e. Analog communication module.
 6. N.C., isolated overload alarm contact.
 7. External overload reset push button.
- F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.

- b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- 2. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
- 3. Nonfusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
- 4. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. N.C. alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
- 5. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. N.C. alarm contact that operates only when MCCB has tripped.

2.3 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

- A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.

- B. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
 - 1. Configuration:
 - a. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
 - b. Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
 - c. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
 - 2. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 3. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 4. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.
 - 5. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor running overload protection.
 - b. Sensors in each phase.
 - c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - e. Analog communication module.
 - 6. N.C. isolated overload alarm contact.
 - 7. External overload reset push button.
- C. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
 - 1. Fusible Disconnecting Means:

- a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class J fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
2. MCP Disconnecting Means:
- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. N.C. alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
3. MCCB Disconnecting Means:
- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. N.C. alarm contact that operates only when MCCB has tripped.

2.4 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

- A. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.
- B. Reduced-Voltage Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
 - 1. Configuration: Standard duty; nonreversible.

2. Starting Mode: Voltage ramping.
3. Stopping Mode: Adjustable torque deceleration.
4. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
5. Shorting Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating.
6. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
7. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 100 VA.
8. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.
9. SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration with external feedback from the motor or driven equipment.
10. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
 - a. Adjusting motor full-load amperes, as a percentage of the controller's rating.
 - b. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
 - c. Adjusting linear acceleration and deceleration ramps, in seconds.
 - d. Initial torque, as a percentage of the nominal motor torque.
 - e. Adjusting torque limit, as a percentage of the nominal motor torque.
 - f. Adjusting maximum start time, in seconds.
 - g. Adjusting voltage boost, as a percentage of the nominal supply voltage.
 - h. Selecting stopping mode and adjusting parameters.
 - i. Selecting motor thermal overload protection class between 5 and 30.
 - j. Activating and de-activating protection modes.

- k. Selecting or activating communication modes.
11. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
 - a. Controller Condition: Ready, starting, running, stopping.
 - b. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
 - c. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
 12. Controller Diagnostics and Protection:
 - a. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
 - b. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
 - c. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component or when the motor is stopped.
 - d. Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
 13. Remote Output Features:
 - a. All outputs prewired to terminal blocks.
 - b. Form C status contacts that change state when controller is running.
 - c. Form C alarm contacts that change state when a fault condition occurs.
 14. Optional Features:
 - a. Analog output for field-selectable assignment of motor operating characteristics; 0 to 10-V dc.
 - b. Additional field-assignable Form C contacts, as indicated, for alarm outputs.
 - c. Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
 - d. Full-voltage bypass contactor operating manually, with NORMAL/BYPASS selector switch. Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring.

- e. Solid-State Overload Relay:
 - 1) Switch or dial selectable for motor running overload protection.
 - 2) Sensors in each phase.
 - 3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
 - 5) Analog communication module.
 - f. N.C., isolated overload alarm contact.
 - g. External overload reset push button.
- C. Combination Reduced-Voltage Solid-State Controller: Factory-assembled combination of reduced-voltage solid-state controller, OCPD, and disconnecting means. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."
- 1. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class L fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
 - 2. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. N.C. alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
 - 3. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current

element for low-level overloads and instantaneous magnetic trip element for short circuits.

- b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. N.C. alarm contact that operates only when MCCB has tripped.
4. Molded-Case Switch Disconnecting Means:
- a. UL 489, NEMA AB 1, and NEMA AB 3, with in-line fuse block for Class J or L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
 - d. N.C. alarm contact that operates only when molded-case switch has tripped.

2.5 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
- 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 3R.
 - 3. Kitchen, Wash-Down Areas: Type 4X, stainless steel.
 - 4. Other Wet or Damp Indoor Locations: Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.6 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
- 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
 - a. Push Buttons: Shrouded as indicated.

- b. Pilot Lights: LED types; colors as indicated; push to test.
 - c. Selector Switches: Rotary type.
- 2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
- 3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.
- B. N.C. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- F. Cover gaskets for Type 1 enclosures.
- G. Spare control wiring terminal blocks, quantity as indicated; wired.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch (100-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible-switch enclosed controller.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- G. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- I. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
- J. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved nameplate.
 3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers at 65 percent.
- E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
- F. Set field-adjustable circuit-breaker trip ranges.

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.

END OF SECTION 262913

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior lighting fixtures.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. IESNA: Illuminating Engineering Society of North America.
- E. LER: Luminaire efficacy rating.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.
- H. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. LED Driver
 - 4. Energy-efficiency data.
 - 5. Life, output (lumens, CRI), and energy-efficiency data for lamps.
- B. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- C. Field quality-control reports.

- D. Special Warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

- 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 EXTRA MATERIAL

- A. Furnish extra materials described that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. LED Packages: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. LED Driver: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate LED "lay-in" style fixtures with ceiling system specified in other portions of this specification.

1.9 WARRANTY

- A. Special Warranty for Drivers: Manufacturer's standard form in which drivers manufacturer agrees to repair or replace drivers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for LED package and associated drivers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings or approved equivalent.
- B. Products with no equals: Provide product indicated on the Drawings – no exceptions. Include break-out material and labor unit costs for each proprietary fixture indicated.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. LED Fixtures: Comply with UL 8750.
- B. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- D. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
- E. Reflecting Surfaces: Provide materials with minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 85 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metalized Film: 90 percent.

2.3 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.4 LED FIXTURES

A. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.

B. Include the following features unless otherwise indicated:

1. Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
2. Each luminaire shall be rated for a minimum operational life of 50,000 hours utilizing a minimum ambient temperature of (25°C).
3. Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
4. Color Rendering Index (CRI) of 82 at a minimum.
5. Color temperature shall be as indicated on light fixture schedule, unless otherwise indicated. Confirm color temperature with engineer and interior designer/architect prior to release to manufacture.
6. Rated lumen maintenance at 70% lumen output for 50,000 hours, unless otherwise indicated.
7. Fixture efficacy of 60 Lumens/Watt, minimum.
8. Provide a minimum five year manufacturer's warranty on LED luminaires including full replacement of any failed components and \$50 labor allowance for each luminaire.
9. Photometry must comply with IESNA LM-79.
10. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
11. 10% attack stock shall be provided for the LEDs & drivers.
12. LED Drivers shall not need constant power. Shall meet NEMA 410 requirements. Shall meet IEC 61000-3-2 harmonic emission limit standard.
13. All luminaires shall have integral quick disconnect for ballast/driver.

C. Technical Requirements

1. Luminaire shall have a minimum efficacy of 60 lumens per watt. The luminaire shall not consume power in the off state.
2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.

4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 15 percent.
5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

D. Thermal Management

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
2. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
3. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
4. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

2.5 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 2. Install lamp(s) in each luminaire.
- B. Temporary Lighting: Use permanent luminaires when approved by Owner and Architect. for temporary lighting shall be permitted subject to the following conditions:

1. Install and energize the minimum number of luminaires necessary.
 2. When construction is sufficiently complete, luminaires used for temporary lighting shall be thoroughly cleaned, and new lamps installed.
- C. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
 - a. 2'x4' fixtures: 4 rods or wires at fixture corner.
 - b. 1'x4' and 2'x2' fixtures: 2 rods or wires at cater-corners of fixture.
 - c. Others (smaller than 1' x 4' and 2'x2'): 1 rod or wire.
 - d. Large fixtures: (larger than 2'x4'); per engineer's recommendations.
 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Division 26 section "Identification for Electrical Systems".
- B. Install labels with panel and circuit numbers on concealed luminaire junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 270010 - TECHNOLOGY GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS AND DEFINITIONS

- A. Scope: This specification section applies to all Division 27 specification sections and all Division 28 specification sections with the exception of Fire Alarm. All systems under the specifications indicated above are referenced also in this contract documents as "technology systems".
- B. Drawings and specifications: The words "drawings" and "specifications" used on this section refer to all contract drawings and specifications describing the scope of work of the technology system.
- C. Installer and Contractor: The word "installer" where used on the drawings or specifications without any further description shall reference the installer of the system under reference. The word "contractor" where used on the drawings or specifications without any further description shall reference to the General Contractor (or Construction Manager) holding the prime agreement with the owner for the construction of this project.
- D. Provide and Install: The word, "provide" where used on the drawings or specifications shall mean, "furnish, install, mount, connect, test, complete, document and make ready for operation". The word "install" where used on the drawings or specifications shall mean, "mount, connect, test, complete, and make ready for operation".
- E. The word Engineer (also referenced as A&E) where used on the drawings or specification refers to the design engineer of the project working for the project architect or the owner. It does not refer to an engineer working for the General contractor, Construction Manager or any of the installers in the project.
- F. Complete systems: All technology systems are intended to be complete systems, including all materials, labor and programming to make it an operation system. A Responsibility matrix has been included with the contract documents to clarify the scope of all systems. Refer to attachment 2 of this specification section [Refer to design drawings for matrix details]
- G. Active equipment: Active equipment is defined as equipment composed of electronic component and electric materials, design to work with power applied to it. Cables are not considered active equipment.

1.2 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. Objective: The intent of the design drawings and specifications is to provide the installer of a technology system a scope of work for bidding purposes and to make sure different bids received by the entity holding the bidding for the technology system are at the same level of scope for comparison purposes. The drawings and specifications are not intended to show every single element of the project to produce a buyout list for the installer. In general, for all technology systems, all active components are specifically called out but small wires and small installation materials (such as nut, bolts, washers, termination blocks, clamps, ties, etc) are not indicated in the documents. Guidelines for installation of those systems are provided in the specification to allow the installer to produce the complete buyout list of materials.
- B. Accuracy: The Drawings are diagrammatic and are not intended to show exact locations of conduit runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, conduits, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Architect or Engineer during construction. Obtain in the field all information relevant

to the placing of technology systems work and in case of interference with other work, proceed as directed by the Architect or Engineer.

- C. Distances: Although most drawings have a scale referenced on each sheet, the drawings are a two dimensional representation of the system, so design drawings do not indicate changes in elevation that cause additional lengths and quantities of materials. It is the responsibility of the installer of each technology system to field verify all distances before bidding to properly estimate all cable distances and materials.
- D. Discrepancies: Notify the A&E of any discrepancies found during construction of the project and do not proceed with that portion of the project, until a written definitive statement is received providing clear direction. If a conflict exists between the contract documents and any applicable code or standard, the most stringent requirement shall be included for this project. The Engineer shall make the decision regarding questionable areas of conflict.
- E. Existing Conditions: All existing conditions might not be indicated in the design drawings. The installer of each system shall check site and existing conditions thoroughly before bidding and advise the Engineer of discrepancies prior to bid.
- F. Coordination: Although design technology drawings were intended to be coordinated with other trades, the fact that installer for other non-technology system might have changes to their design drawings, requires the Contractor to produce coordination drawings for a specific space, including all elements of all trades for space planning and coordination purposes.

1.3 ABBREVIATIONS

- A. Abbreviations: The following abbreviations or initials may be used:
 - 1. ABV CLG - Above Ceiling
 - 2. AC - Alternating Current
 - 3. ADA - American Disabilities Act
 - 4. AFF - Above Finished Floor
 - 5. AFG - Above Finished Grade
 - 6. AMP - Ampere
 - 7. ANSI - American National Standards Institute
 - 8. AWG - American Wire Gauge
 - 9. BC - Bare Copper
 - 10. CCTV - Closed Circuit Television
 - 11. CATV - Community antenna television
 - 12. CLG - Ceiling
 - 13. COAX - Coaxial Cable
 - 14. CPU - Central Processing Unit
 - 15. DC - Direct Current
 - 16. DEG - Degree
 - 17. EMT – Electrical Metallic Tubing
 - 18. GND - Ground
 - 19. IDF - Intermediate Distribution Frame (Telecom Room)
 - 20. IMC - Intermediate Metallic Conduit
 - 21. IN - Inches
 - 22. IP - Internet Protocol
 - 23. JB - Junction Box
 - 24. KVA - Kilo-Volt-Amps
 - 25. KW - Kilowatts
 - 26. LBS - Pounds
 - 27. LED - Light Emitting Diode
 - 28. MAX - Maximum

- 29. MDF - Main Distribution Frame (Main Telecom Room)
- 30. MIC - Microphone
- 31. MIN - Minimum
- 32. MTD - Mounted
- 33. MTG - Mounting
- 34. NEC - National Electrical Code
- 35. NECA - National Electrical Contractors Association
- 36. NEMA - National Electrical Manufacturers Association
- 37. NFPA - National Fire Protection Association
- 38. NIC - Not in Contract
- 39. OFE - Owner furnished equipment
- 40. OSHA - Occupational Safety and Health Administration
- 41. PB - Pullbox
- 42. PWR - Power
- 43. PVC - Polyvinylchloride
- 44. EF - Telecommunications Entrance Facility
- 45. TR - Telecommunications Room
- 46. TTB - Telephone Terminal Board
- 47. V - Volt
- 48. WP - Weatherproof

1.4 CODES AND STANDARDS

- A. Application: The codes, standards and practices listed herein generally apply to the entire project and all technology systems. Other codes, standards or practices that are more specific will be referenced within a particular specification.
- B. Requirements: All articles, products, materials, fixtures, forms or types of construction covered in the specifications will be required to meet or exceed all applicable standards of manufacturer, testing, performance, capabilities, procedures and installation according to the requirements of ANSI, NEMA, IEEE, NEC, BICSI and TIA referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents which exceed but are not contrary to governing codes shall be followed.
- C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed technology system installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes.
- D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements. List of applicable codes:
 - 1. State Code: Pennsylvania Administrative Code
 - 2. Building Code: Philadelphia Building Code, 2018
 - 3. Manuals: Accessibility Requirements Manual - Philadelphia Department of Community Affairs.
 - 4. International Building Code, 2018
- E. UL Labels: All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. No equipment shall be installed if there is no labeling or listing service is available for such equipment.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. Definitions:

1. Basis of design: A product or group of products from an identified manufacturer that was used as the basis of systems layouts and installation details, part of the contract documents.
 2. Prototype: Is a product or a group of products that are not yet ready for commercial use because they are in the testing phase (Beta testing) of the product development.
 3. Alternates: Products or manufacturers listed in the contract documents as acceptable compare to the basis of design. Use of alternates shall follow the same system architecture as the basis of design.
 4. Obsolete: A product that has been discontinued by the manufacturer or declared in end of life, and it is no longer being manufactured.
 5. Substitution: A product not listed in the contract documents but capable of similar characteristics as the basis of design operating as a direct replacement in the system in reference. The installers can propose a substitution if all requirements are met as indicated in this specification.
 6. Substitutions that create a change in system architecture are products that create a very different system configuration impacting other trades (i.e. change in power/cooling requirements, changes in raceways layout or sizes, changes in equipment space requirements, changes in low voltage wiring layouts, types and quantities, etc) but providing a similar end result as the system/products basis of design.
- B. Use of Prototype. Prototypes are not allowed in any technology system.
- C. Use of alternates. Alternates are allowed and installer shall follow these requirements:
1. Where several brand names make or manufacturers are listed as acceptable alternates each shall be regarded as equally acceptable, based on the design selection. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where three or more manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance.
 2. The use of alternate products does not allow the change of system architecture with such products.
- D. Use of substitutions. Substitutions are only allowed when they meet all the requirements below:
1. Substitutions are only allowed when a particular specification section for a technology system, allows the use of substitutions for that particular system.
 2. The performance of all substitutions components must meet or exceed those of the basis of design. Should an installer wish to submit a substitution product or a product set stated in the construction documents as 'acceptable', it shall be the responsibility of the installer to submit to the Engineer an item-for-item CROSS REFERENCE for all specifications of the product, all related specifications and product data sheets, for the proposed substitution. Use the substitution request form indicated in Attachment 1 of this specification.
 3. The Engineer has the authority to reject a substitution without cause and the installer shall provide the basis of design and no additional compensation.
 4. Substitutions of unnamed manufacturers will not be acceptable.
 5. Certification of substitutions: When a basis of design is specified to be in accordance with a trade association or government standard requested by the Engineer, installer shall provide a certificate that the substitution complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
 6. Substitutions that create a change in system architecture are not allowed [allowed under the following conditions]:
 - a. Substitution request for this type of system requires submitting the overall cost of substitution including the cost of changing other systems affected as well as the re-design cost for such systems. Without this information this type of substitution will not be evaluated at all.

1.6 SHOP DRAWINGS AND SUBMITTALS

- A. General: Shop drawings shall be submitted for equipment and material as indicated in the individual specification sections for each system. .
- B. Quantity of shop drawings submittals: Follow Division 1 requirements for quantity of shop drawings and submitting requirements. If the project does not have a Division 1 specification, shop drawings shall be submitted in quantity of one (1) for electronic format submittal and quantity of four (4) for hardcopies.
- C. Electronic submittals. Submittals in electronic format (PDF) are accepted.
- D. When cut sheets of products are submitted and the manufacturer cut sheets indicate several model numbers or variations of the same product, the cut sheet shall be highlighted by the installer to indicate the specific product that will be provided for this project. Submittals received with cut sheets indicating multiple parts numbers and not highlighted will be rejected and not reviewed.
- E. Equipment and material quantities are not reviewed by the A&E as part of this submittal process. Equipment quantities are to be provided by the installer as indicated in contract documents. Approved shop drawings indicating any changes in equipment quantities or overall scope of work different from contract documents does not constitute approval by the A&E of those changes. The contract documents and any changes issued by the A&E in the form of Supplemental Information during the construction process are always to be followed for equipment quantities and scope of work.
- F. All electronic equipment prone to obsolescence and with lead times less than 3 months shall be submitted for approval no sooner than 12 month before the date set for substantial completion of the project. Electronic equipment prone to obsolescence includes devices like flat panel displays, transceivers, servers, players, workstation and routers
- G. Equipment and materials installed not in accordance with the approved shop drawings shall be replaced at installer's expense.
- H. Multiple stages of shop drawings shall be required as indicated in each specification section. For final completion and testing the installer shall provide a submittal with the following information:
 - 1. Detailed course syllabus for each type of training required in the specifications
 - 2. A proposed schedule of training sessions in compliance with the specification sections and indicating place where the training will take place.
 - 3. A copy of all training material to be used during each session.
 - 4. Test result sheets for all testing done by the installer prior to the system acceptance test.

PART 2 - PRODUCTS

2.1 IDENTIFICATION AND LABELING TAGS

- A. All conduit, cabinets, cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified with pre-printed labels or tags.
- B. The only approved types of labels for inside premise environments for any technology systems are:
 - 1. Non-laminated thermal transfer labels, printed with a high quality thermal transfer printer.
 - 2. Laminated thermal transfer labels printed with a high quality thermal transfer printer.
 - 3. Thermal transfer polyolefin tape printed with a high quality thermal transfer printer.

- C. For labeling of cables or equipment in outdoor environments use only marker plates attached to cable or equipment with cable ties. Do not use any labels with adhesive materials. Use different color plates for different cable types. Use only waterproof ink for writing on marker plates.
- D. Any type of write-on labels (except for outdoor marker plates), hand writing on cable jackets or directly on equipment, labels made with masking tape or any other type of tape not listed in previous paragraph are not acceptable and shall be corrected with approved labeling methods at no additional cost to the owner.
- E. Approved manufacturer:
 - 1. Rhino,
 - 2. Brady,
 - 3. Panduit or
 - 4. approved equal

2.2 TECHNOLOGY EQUIPMENT AND MATERIALS

- A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacture of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear a label as indicated in paragraph 1.4.E. of this section.
- B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer and the contract documents.
- C. Required Accessories: All equipment specified in the technology systems shall be provided with all required accessories for proper operation and mounting. Typically these accessories are not specifically indicated in the design drawings but shall be provided per this specification section. Such accessories include items such as power supplies, power cords, rack ears, rack rails, bolts, lugs, faceplates, etc.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. WORKMANSHIP: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.
- B. STANDARD OF QUALITY: To define good workmanship, all installation practices described in BICSI standards shall be followed.
- C. PROTECTION OF EQUIPMENT: Equipment for Technology systems shall at all times during construction be adequately protected against mechanical/chemical damage by the elements or work performed by other trades. Equipment shall be stored in dry permanent shelters. If equipment or materials has been damaged, such equipment shall be replaced at no additional cost or time extension to the Contract. Damaged equipment and materials include the following conditions:
 - 1. Equipment that has visible scratches, cracks or equipment that has paint or finished surface peeled off.
 - 2. Equipment with visible indication of rust or water intrusion.
 - 3. Equipment that has dents on the metal enclosures and are clearly visible to the end user.

4. Equipment that has been sprayed with paint, fire proofing materials, or other type of chemicals, when the equipment was not intended to have this type of materials applied to it, per contract documents.
 5. Equipment that has been burnt by controlled fires, power surges, power sags or by lightning.
 6. Equipment that has a known damage to any parts, electronic board or component, even if such component or board has no specific use in the project.
 7. Cables that have visible damages to the jackets even if cables are not broken and still provide electrical continuity.
 8. Cables sprayed with paints that affect the warranty of the cable as defined by the cable manufacturer.
 9. Equipment with screws with stripped heads.
- D. **CLEAN EQUIPMENT:** All equipment installed in spaces accessible to the building occupants like in racks, cabinets, wall mounted panels, credenzas, etc. shall be free of dust at the time the space part of the project gets the final Certificate of Occupancy and at the time of the acceptance test by the A&E. A clean equipment is defined as an equipment that if wiped with a finger, in any surface, does not leave visible debris and dust in the finger, also equipment with no visible signs of dust inside the equipment, like in ventilation fans.
- E. **IDENTIFICATION AND TAGGING:** All technology systems items shall be labeled and identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system which it serves or controls. Refer to Identification Section of the specifications for additional information. All labels of equipment and wiring shall match the labeling used in the shop drawings for the system.

3.2 COORDINATION

- A. **General:** The installer shall compare shop drawings with those of other trades and report any conflicts between them to the A&E. Obtain from the A&E written instructions to make the necessary changes in any of the affected work. All work shall be installed in cooperation with other Trades installing interrelated work.
- B. **Adjustments:** Locations of conduit and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of all systems prior to fabrication or installation.
- C. **Replacement:** All work shall be installed in a way to permit removal (without damage to other parts) of all other system components provided under this Contract requiring periodic replacement or maintenance. All conduits shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.

3.3 REQUEST OF IP ADDRESSES

- A. **General:** When contract document require the installer of any of the technology systems to use IP addresses for the configuration of such system, inside the owner's controlled IP network, the installer shall request the owner to provide such IP addresses. The installer shall request such information no less than one (1) month in advance from the moment the installer will be programming the system and by using the form named "Network Connections Programming Plan" indicated in Attachment 3 of this specification. An electronic copy of this form is available upon request from TLC Engineering.
- B. **Completing the form.** The Network Connections Programming plan shall be completed in separate by each trade that requires IP addresses. This form has two parts. The first part indicates all the different device types for a system (i.e. cameras, workstation, servers, controllers, VoIP phones, etc). The second

part is a list of all devices required classified by their type and properly indicating location where the device will be used.

- C. Request that do not follow this process, or have incomplete information will be ignored and will not be processed.
- D. Reprogramming cost of any technology systems due to un-approved addresses used by the installer shall be at the installer's expense

3.4 TELECOM ROOM/EQUIPMENT ROOM READINESS

- A. In any projects where the technology systems require the use of network equipment (switches, routers, firewalls, etc) provided by the owner, the Contractor shall complete all telecom rooms to a point where they are suitable for the owner to deploy such equipment in those rooms. At a minimum the following conditions shall be met at all rooms in order for the owner to install the equipment:
 - 1. All power outlets in the telecom rooms shall be fed from the permanent source of power. Temporary power shall not be accepted.
 - 2. Backup power (generator and/or UPS) shall be already operation, tested and connected to the final power distribution system.
 - 3. The mechanical equipment providing the cooling for the telecom rooms shall be fully operational. Temporary cooling shall not be accepted.
 - 4. Fire suppression system (sprinkler or gas based system) protecting the telecom rooms shall be fully operational and tested.
 - 5. All light fixtures in the telecom rooms shall be fully operational.
 - 6. All walls to the telecom rooms shall be completed and including the last coat of paint.
 - 7. The ceiling and flooring of the telecom rooms shall be finished.
 - 8. All horizontal and backbone cabling system part of the structured cabling system (SCS) shall be installed, terminated and tested.
 - 9. The final and permanent doors to the telecom rooms shall be installed with a key core different from all other construction cores in the site.
 - 10. Telecom rooms shall be cleared of any materials being stored inside the room.
 - 11. Telecom rooms shall be clean. Clean will be measured as not having any debris left in the room and not having dust in rack, cabinets, or wall mounted panels. If wiping a finger in any of the surfaces of such equipment leaves visible dust residue in the finger, the room will not be considered clean.
 - 12. Hallways and rooms leading into the telecom rooms shall have no more sanding to be done in the walls and the floor shall be completed to avoid dust from these spaces moving into the telecom rooms.
 - 13. Prior to the owner deploying the equipment in these rooms, the Contractor shall provide disposable sticky mats at the entrance of each telecom room to capture dust and/or dirt from people's shoes or boots coming into the room. The sticky mats shall be selected as to cover the width of the door opening. Sticky mats shall contain no less than 60 sheets in each unit. Used sheets of the mats shall be replaced no less than on a daily basis or if worn out before the end of the day. Sticky mats shall be provided until the project receives the final Certificate of Occupancy.
- B. In projects where the network equipment is part of the contract documents, the contractor is required to provide all equipment functioning and clean at the end of the project. The contractor is responsible to determine at what point this delicate equipment can be installed in the telecom room. The contractor shall make sure the recommended manufacturer guidelines are applied to the installation of the equipment when it comes to cleanliness. It is highly recommended that all steps indicated above are followed even for this type of project.

3.5 SYSTEMS WARRANTY AND SERVICE

- A. General: At a minimum all technology system shall include a warranty from the manufacturer and installer of the system for no less than one (1) year with the following exceptions:
1. Structured Cabling system shall have a warranty longer than one year as indicated in that specification section.
 2. When specific equipment or software manufacturers include a warranty longer than one year, the manufacturer's warranty shall be transferred to the owner in the same terms as indicated by the manufacturer.
- B. Warranty coverage. The warranty for the technology system shall cover the following elements:
1. All equipment parts, cabling and materials.
 2. Any software updates/patches issued during the warranty period by the manufacturer.
 3. The labor to replace those parts and programming time to re-configure equipment.
 4. Shipping and freight charges to send equipment back and forth from the manufacturer and/or site.
 5. Tool rentals such as scaffold or lifts to access equipment.
 6. The troubleshooting time to detect the faults in the system.
 7. All travel time and expenses associated with the service.
- C. Start of warranty. The warranty period for the technology systems starts the day the project gets the Certificate of Occupancy (CO), for new construction projects. For retrofit jobs of a particular system, the warranty starts when the project is accepted by A&E. For most equipment/software manufacturer's the warranty period starts when the equipment is shipped from the factory, so it is the responsibility of the installer of each system to provide additional warranty coverage from the manufacturer to cover the additional time of warranty up to the CO date plus one year.
- D. Service calls. During the warranty period the installer shall support the system when called by owner/contractor for service. All equipment/software service shall be done by personnel with the same qualifications as the personnel who installed the system and as indicated in each technology system specification section. Service calls shall be taken during business hours (same time zone as the project) for normal service and twenty (24) hours three hundred and sixty five (365) days in the year for emergency service. Emergency Service shall be defined as the loss or failure of any critical component necessary to maintain the overall integrity and operation of the system. Normal service shall be defined as the loss or failure of a system component that does not compromise the complete operation of the system and allows the owner to operate the system at a minimum of 90% of its capacity. See individual specification sections for delineation on critical components and normal service.
- E. Response time for service. The maximum allowed response time after a service call for emergency service shall be four (4) hours and for normal service twenty four (24) hours.
- F. Equipment registration. All equipment/software part of the technology system shall be registered to the owner with the manufacturer of the equipment/software for warranty and support. Equipment/software registered with the manufacturer to the name of the Contractor or installer shall be removed from the project and replaced with equal equipment registered to the owner at no additional cost to the owner.
- G. Periodic preventive maintenance visits. During the warranty period the installer of the system shall provide no less than two (2) preventive maintenance services. These services shall be provided at 6 months from start of the warranty period and a few weeks before the end of the warranty period. The installer of the system shall coordinate with the owner the precise dates for this type of service. During these visits the following task shall be perform:
1. Clean up of any active equipment that shows visible accumulation of dirt, dust of debris of any kind.
 2. Replacement of any consumable parts in the system that require replacement per manufacturer's instructions during the warranty period, such as filters.
 3. Oiling/greasing of any mechanical parts that require period maintenance as per manufacturer's instructions during the warranty period.

4. Run manufacturer's recommended test for each piece of equipment installed. The installer shall provide at the end of the service a report of such test.
5. Visual observation of all devices in the system to spot any anomalies.
6. Review of error logs from any system components and analysis of such logs with explanation to owner on the cause of those errors.

- H. Extended service agreement. Prior to final acceptance testing, and within thirty 30-days of project completion, the installer of each technology system shall submit to the Owner an option to purchase extended service coverage. This proposal shall provide for the purchase option of 1, 3, or 5, year coverage. Coverage shall include, at a minimum, the same provisions as during the warranty period.

3.6 COMISSIONING

- A. This project will be commissioned by the A&E or by a third party company designated by the owner. The commissioning process will consist of a third party testing by the commissioning agent of a percentage of the installed infrastructure.
- B. The installer of each system shall notify the owner when the project is ready for commissioning. The installation is ready for commissioning once the installer is complete with the testing of the system and the identification process has been completed.
- C. The installer shall be available on site to resolve any results discrepancies between the test results provided by the installer of the system and the commissioning agent.

3.7 ENGINEER'S FINAL ACCEPTANCE TEST

- A. The technology systems shall be tested during installation by the installer as frequently as required to solve any installation issues and non compliance of system specifications. Technology systems will not be considered delivered to the owner until final acceptance test is passed. The final acceptance test shall be done in presence of the A&E and/or the owner. The installer shall request in writing with 2 weeks in advance the presence of the A&E and/or owner for the final acceptance test.
- B. In order for the installer of the system to request final acceptance the following task shall be completed:
1. All components shall be inspected to ensure they have been properly installed by the installer, securely attached, and remain clean and unmarred
 2. All equipment shall be properly adjusted, clearly labeled, and fully operational.
 3. The installer shall have tested the system previously to ensure the final acceptance test will be successful. Detailed proof of test shall be sent to the A&E with the request for final acceptance
 4. All permanent and final labels as requested in the identification and tagging section of this specification are completed.
 5. No temporary conditions shall be present in the system.
 6. All batteries on all system components shall be connected.
 7. All system programming shall be completed as indicated in the specification for each technology system.
- C. All test equipment required for the Final acceptance shall be provided by the installer of the system unless specifically indicated by the A&E.
- D. The A&E shall define the scope of the testing but the installer shall be prepared for testing every single component of the system. During the day of the test the A&E will indicate the testing process and procedures for each system. Test could include operation of the system during power outages. The installer of the system shall be available during the complete testing process to answer questions from the

Engineer and to demonstrate specific parts of the system. If personnel from the installer or test equipment is not available, the test will be considered and marked as a failure.

- E. A punch list of the items to be corrected will be prepared by the A&E during the final acceptance test. The installer shall correct all items and request a second day for verification of all punch-list items by the A&E and Owner. During the second test, no additional punch list items shall be expected, and only the items in the punch list will be tested.
- F. If during the testing process the A&E and/or Owner consider that the rate of failure of the test is too high (more than 5 failures or non-compliance with specifications in one hour of test), the test will be cancelled unilaterally by the A&E and/or owner. The installer shall correct all items and re-schedule the final acceptance test again. The new test will start over from the beginning and nothing previously tested will be accepted. The installer shall not be entitled to additional compensation for the additional effort to test the system during this condition. To the contrary, the Contractor/Installer shall reimburse the owner of the project with the cost of the additional hours of testing required to be spent by the A&E and owner's team. The rate to be used for this reimbursement will be \$150 per hour per person required by the A&E and Owner to complete the test. [Do not use this paragraph on DB projects]
- G. Upon successful completion of the final acceptance test the installer of the system will receive a written notice by the A&E and/or Owner acknowledging the acceptance of the test
- H. See individual specification sections for system specific requirements for testing.

3.8 TRAINING AND INSTRUCTION

- A. Training for each technology system shall be provided as indicated in this specification and in the individual specification section for each system.
- B. The following training guidelines shall be followed for all technology system
 1. Training shall not be scheduled in a way that no attendee or presenter shall be required to attend more than 6 hours of training per day.
 2. Prior to starting all training, the training submittal shall be approved. See section one of this specification for details on the training submittal
 3. No training shall be scheduled prior to the system being completed and accepted by the A&E.
 4. Training shall be conducted during normal business hours of the client, at a date and time of mutual convenience to the Owner and installer. All training sessions need to be scheduled by the installer at least 2 weeks in advance. The Owner shall be notified in writing by the installer on when are the possible dates for each session.
 5. All different types of training shall be videotaped and delivered to the owner as part of the close out information in digital copy. All tapes shall be recorded in hi-quality MPEG2 or HD recorders, and the media turned to the owner shall be in electronic format viewable through QuickTime or Windows Media Player.
 6. The installer is responsible for completing list of attendants for each session of training. All these sheets shall be submitted as part of the close out information

3.9 AS BUILT DOCUMENTS

- A. Production: During the course of this project the contractor shall maintain record "as-built drawings". One set shall be maintained at the site and at all times and it shall be accurate, clear, and complete, showing the actual location of all equipment as installed. The "As-Built" drawings shall show all technology systems work installed complete to the present stage of progress. These drawings shall be available for review by the A&E's field representatives at all times.

- B. Completion: At the completion of the Work, transfer onto the second set of drawings all changes marked in colored and submit to the A&E.
- C. Final: Upon installer's completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings. Submit full size drawings and one (1) set of CAD/Autodesk Revit© disks for review and acceptance.
- D. Additional documents. At project completion, the installer of the technology system shall provide, as part of the as-built documents, updated tables, equipment schedules, configuration worksheets and labeling system used. See individual system specification section for more details on these documents.
- E. See individual specification sections for each system for additional requirements for As-Built documents.

3.10 CLOSE OUT DOCUMENTS

- A. Closeout information shall be provided to the owner in electronic format at the end of the project. The file shall be organized by each system and shall follow this organization:
 - 1. PART 1 – OPERATION AND MAINTENANCE MANUALS. Operation and Maintenance manuals as issued by the manufacturer of each system's component. Such manuals shall include all maintenance procedures required to be done by the owner. Also, when required by each individual specification section, a short form operation guide, prepared by installer) for the system.
 - 2. PART 2 – INVENTORY OF EQUIPMENT INSTALLED. A detailed list of all relevant active equipment (equipment with electronic components with a market value over \$200) installed in the project including the following information and presented in electronic format (Microsoft Excel):
 - a. Make
 - b. Model
 - c. Serial number
 - d. Room location
 - e. Warranty period, including manufacturer's extended warranties.
 - 3. PART 3 – PROOF OWNERSHIP, DELIVERY AND ACCEPTANCE. The following letters/documents shall be attached in this part:
 - a. Acceptance letter signed by A&E for each of the technology systems installed.
 - b. Proof of training by submitting sign in sheets for each training session done
 - c. Signed transmittal for all training videos and training material.
 - d. Signed transmittal for all spare parts and consumables delivered to the owner.
 - e. A list of all the user names and passwords for all the different software programs used by the technology systems and any equipment with password codes. All levels of passwords shall be provided, from the lowest hierarchy to the highest.
 - f. At least four (4) copies of all physical keys to different devices part of the technology systems. Each key shall be individually tagged in a key ring. All keys shall be included and organized inside a key ring management enclosure.
 - g. A list of all software modules and licenses delivered to the owner. The list shall include part numbers, serial numbers, license certificate of authenticity, hardware key (dongles) numbers and software version. This list shall have a clear signature, name and date on person that received this software by the Owner.
 - h. A copy of all official equipment and software registrations with manufacturer.
 - 4. PART 4 – AS BUILT DOCUMENTS. All as-built documents as indicated in this specification section

END OF SECTION 270010

ATTACHMENT 1 – SUBSTITUTION REQUEST FORM

Substitution Request Form

Request No.:

Date:

Project:	Specified Manufacturer:	Proposed Manufacturer:
Spec Section:	Specified Model No.:	Proposed Model No.:
Item(s):	Reason(s) for not providing specified item:	
*Please attach product description, drawings, photographs, performance and test data, samples, and other information necessary for side-by-side evaluation. Fill in all blanks.		

Provide substantiated reason for requested substitution below.
Does the requested substitution affect dimensions, locations, or configurations? (Yes/No) Please explain below (attach drawings if necessary).
What are the differences between the specified item and the requested item? Please list below.
Will the Contractor pay for any changes to the building design, including engineering and detailing costs caused by the approval? (Yes/No) If no, explain below. Describe modifications required to install or accommodate the requested change.
Will approval affect the work of other trades, including the Construction schedule? (Yes/No) If yes, please explain below.

Manufacturer's guarantees of the proposed and specified items are: (Same/Different) If different, please explain below.
Does the proposed item meet all applicable codes, ordinances, and regulations for this specific application? (Yes/No) If no, please explain below.
Has the proposed item been used locally in similar applications? (Yes/No) If yes, please explain below and give nearest location.
Will maintenance and service parts be locally available for the requested item? (Yes/No) Please explain below. If not locally available, give nearest location.
Will the requested item require waiving of any qualifications or other requirements? (Yes/No) If yes, please explain below.
Are there any license fees or royalties associated with the requested substitution? (Yes/No) If yes, please explain below.

If approved, will the Owner receive a credit for the proposed alternate material? (Yes/No) If no, please explain below.
Does the proposed alternate material meet the same applicable standards (ASTM, ANSI, UL, FS) as the specified item? (Yes/No) If no, please explain below (attach drawings if necessary).
Identify the recycled materials or components or features that lead to the claims to being "Green":
Has the required line-by-line comparison been included? (Yes/No) If no, please explain below.

The following Purchase Order or billing number is to be used for billing the Contractor for costs incurred in evaluating and if applicable accommodating the requested substitution:

The undersigned agrees to pay for the Designer's review time and for changes to the building design, including review, re-design, engineering, drawings, and other costs caused by the requested substitution.

Signature

Name (please print)

The Engineer will not be required to approve any product that is not equal or suitable for the specific application and functionality of this project.

ATTACHMENT 2 – RESPONSIBILITY MATRIX

DESIGN AND CONSTRUCTION RESPONSIBILITIES					
ITEM	SYSTEM	SCOPE	DESIGN RESPONSIBILITY	PROCUREMENT RESPONSIBILITY	CONSTRUCTION RESPONSIBILITY
1.00	VOICE SYSTEM (TELEPHONE COMMUNICATIONS SYSTEM ALL AREAS)				
1.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
1.02	INSIDE PREMISE WIRING	Structured cabling system	TLC	CM	CM
1.03	OUTSIDE PREMISE WIRING IN PRIVATE CAMPUS	Structured cabling system	TLC	CM	CM
1.04	OUTSIDE PREMISE WIRING FROM SERVICE PROVIDERS	Fiber and copper for services	TLC/Owner	S.P.	S.P.
1.05	PATCHING OF VOICE LINES	Patching at path panel and work areas	TLC	N.A.	OWNER
1.06	PHONE SWITCH	Equipment selection, sizing, equipment layout, RFP	OWNER	OWNER	OWNER
2.00	DATA SYSTEM (COMPUTER NETWORKS ALL AREAS)				
2.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
2.02	INSIDE PREMISE WIRING	Structured cabling system	TLC	CM	CM
2.03	PATCHING OF DATE LINES LINES	Patching at path panel and work areas	TLC	N.A.	OWNER
2.04	ACTIVE ELECTRONICS (NETWORKING EQUIPMENT, SWITCHES, ROUTERS, SERVERS AND COMPUTERS)	Equipment selection, sizing, equipment layout, RFP	OWNER	OWNER	OWNER
3.00	TELECOM ROOM OUTFIT				
3.01	PLYWOOD AND WALL SLEEVES	Plywood and sleeves for cables	TLC	CM	CM
3.02	GROUNDING SYSTEM	Ground bar and ground bass	TLC	CM	CM
3.02	RACKS, WIRE MANAGERS AND LADDER TRAY	Racks and all passive elements	TLC	CM	CM
4.00	CATV DISTRIBUTION (CABLE TV FOR ALL AREAS)				
4.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
4.02	INSIDE PREMISE WIRING	Coaxial cable	TLC	CM	CM
4.03	DISTRIBUTION DEVICES	TAPS, amplifiers, splitter, DC	TLC	CM	CM
4.04	TVS IN PATIENT ROOMS	TVs not part of the system	MEP	OWNER	CM
4.05	MOUNTS FOR TVS	Mounts for the TVS	MEP	OWNER	CM
5.00	AV SYSTEMS/ PAGING				
5.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
5.02	INSIDE PREMISE WIRING	AV wiring for systems	TLC	CM	CM
5.03	ACTIVE ELECTRONICS	Projectors, presentation control system, paging system, etc.	TLC	CM	CM
6.00	SECURITY SYSTEMS, BUILDING CCTV AND ACCESS CONTROL				
6.01	RACEWAYS	Conduit, boxes, cable tray, etc.	TLC	CM	CM
6.02	INSIDE PREMISE WIRING	Cables for cameras and card access	TLC	CM	CM
6.03	ACTIVE ELECTRONICS	Cameras, DVRs, Access control panels, readers, etc.	TLC	CM	CM
6.04	LOCKING DEVICES	Magnets, electric mortise locks	Architect	CM	CM
7.00	EMERGENCY POWER BACKUP (UPS) FOR ACTIVE EQUIPMENT				
7.01	POWER WIRING	Conduit, cables and circuits	TLC	CM	CM
7.02	ACTIVE EQUIPMENT - SMALL UNITS	UPS units in racks or in work areas	OWNER	OWNER	OWNER
7.03	ACTIVE EQUIPMENT - LARGE UNITS	Central UPS system	TLC	CM	CM
8.00	FIRE ALARM AND BUILDING MANAGEMENT SYSTEM				
8.01	RACEWAYS & WIRING	Conduit, cables, patch panels, cable tray outlets, etc.	TLC	CM	CM

DESIGN AND CONSTRUCTION RESPONSIBILITIES					
ITEM	SYSTEM	SCOPE	DESIGN RESPONSIBILITY	PROCUREMENT RESPONSIBILITY	CONSTRUCTION RESPONSIBILITY
8.02	ACTIVE ELECTRONICS	Data gathering panels, sensors, etc	TLC	CM	CM
9.00	DISTRIBUTED ANTENNA SYSTEM				
9.01	RACEWAYS & WIRING	Conduit, cables, patch panels, cable tray outlets, etc	TLC	CM	CM
9.02	INSIDE PREMISE WIRING	Cable , grounding	VENDOR	VENDOR	VENDOR
9.01	ACTIVE ELECTRONICS	Head end system and antennas	VENDOR	VENDOR	VENDOR
10.00	MEDICAL EQUIPMENT				
10.01	RACEWAYS & WIRING	Conduit, cables, patch panels, cable tray outlets, etc	TLC	CM	CM
10.02	WIRING FOR SYSTEMS USING SCS	SCS cable components	TLC	CM	CM
10.03	ASY FOR SCS CABLE	SCS cable components	VENDOR	VENDOR	VENDOR
10.01	ACTIVE ELECTRONICS, PIXIS, TELEMETRY, DICTATION, PATIENT MONITORING	Head end system and antennas	VENDOR	VENDOR	VENDOR

ATTACHMENT 3 – NETWORK CONNECTIONS PROGRAMMING PLAN

SECTION 270526 – GROUNDING AND BONDING FOR TELECOMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section [Remove this paragraph for Prime projects].
- B. General: For grounding electrode system and equipment grounding system for Telecommunications refer to specification section 260526. In all cases the applicable electrical codes for grounding and bonding for telecommunications shall be met.
- C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 260526 Grounding and Bonding for Electrical Systems
- D. General. For a bonding diagram for telecommunications refer to T Drawings.
- E. General. The bonding approach required herein is intended to work in concert with the cabling topology as specified in Specification section 271000 and installed in accordance with specification section 270528.
- F. Reference Standards:
 - 1. TIA-607-D
 - 2. TIA-568.0-E
 - 3. TIA-606-C
 - 4. UL 1863 Communication Circuit Accessories
 - 5. NFPA 70 – NEC
 - 6. IEEE Std. 1100-1992, Powering and Grounding Sensitive Electronic Equipment.
 - 7. BICSI TDMM, Telecommunications Distribution Method Manual.
 - 8. NFPA 780
 - 9. R56 “Standard and Guidelines for Communications Sites” Motorola Inc. April 2017.
- G. Standard compliance: This project requires compliance with R56 grounding standards. The requirements of R56 grounding standards are more stringent and supersede the requirements indicated in this specification section.

1.2 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

1.3 SHOP DRAWINGS AND SUBMITTALS

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. The installer of the Telecommunications Grounding systems shall provide the following information in the shop drawings phase of the project:
 - 1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
 - 2. A spreadsheet indicating telecommunications ground bar information selection for each telecommunications room indicated in the design drawings, including the following information:
 - a. Room Name or number
 - b. Quantity of ground bars
 - c. Height of each ground bar
 - d. Length of each ground bar
 - e. Number of holes in each ground bar
 - f. Label for each ground bar
 - 3. A drawing indicating the following information:
 - a. Location of all telecommunications ground bars and routing of all telecommunications grounding backbones.
 - b. Wire size charts for all telecommunications grounding backbones in the project.
 - c. All labels to be used in telecommunications backbone cables, bonding conductors and telecommunications ground bars.
 - 4. A detailed drawing layout of the Mesh Common Bonding Network (MCBN) for all spaces with raised floor in the project, indicating bonding conductor spacing and bonding ground bars.

1.4 ABBREVIATIONS

- A. General: The following abbreviations are used in this specification section:
 - 1. TBB - Telecommunications Bonding Backbone
 - 2. BC - Bonding Conductor
 - 3. EMT - Electrical Metallic Tubing
 - 4. RMC - Rigid Metal Conduit

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- A. The TMGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TMGB shall be located and provided in the Main Telecommunication Room in each building. The TMGB must also be listed by a nationally recognized testing laboratory (NRTL).
- B. The TMGB shall have the following specifications:
 - 1. Material: Copper with a thin plated finish.

2. Thickness: ¼" thick
 3. Width: No less than 4"
 4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 14" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
 - a. Two holes required for each TBB termination.
 - b. Two holes for each cabinet or rack row in the room
 - c. Two holes for each protector block in the room
 - d. Two holes for each layer of ladder tray above the rack.
 - e. Two holes for each set of conduit sleeves entering the room
 - f. 20% of spare capacity shall be available after all terminations are done.
 - g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.
 5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16"
 6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.
- C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.
- D. Approved manufacturers:
1. Panduit,
 2. Erico or
 3. approved equal.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR INTERIOR USE

- A. The TGB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. The TGB shall be located and provided in each telecommunication room (except the main telecommunication room) in each building and any other additional locations as indicated in the drawings. The TGB must also be listed by a nationally recognized testing laboratory (NRTL).
- B. The TMGB shall have the following specifications:
1. Material: Copper with a thin plated finish.
 2. Thickness: ¼" thick
 3. Width: No less than 4"
 4. Length: The installer of the grounding system shall estimate the length of the bar as to have enough pre-drilled holes for all BCs in the room. The bar shall be no less than 12" long. The installer shall follow the following criteria in estimating the amount of pre-drilled holes required in the TMGB:
 - a. Two holes required for each TBB termination.
 - b. Two holes for each cabinet or rack row in the room
 - c. Two holes for each protector block in the room
 - d. Two holes for each layer of ladder tray above the rack.
 - e. Two holes for each set of conduit sleeves entering the room
 - f. 20% of spare capacity shall be available after all terminations are done.
 - g. If quantity of holes exceeds the maximum available by a manufacturer, multiple bars shall be provided as to match the criteria indicated above.

5. Pre-drilled holes: All pre-drilled holes shall have a diameter of 5/16"
 6. Hole spacing: All pre-drilled holes shall have a minimum spacing matching the spacing of the holes in the long barrel ground lugs.
- C. The TMGB shall be installed in the wall with stand offs and isolators. Isolators shall be rated at 600V.
- D. Approved manufacturers:
1. Panduit,
 2. Erico or
 3. approved equal.

2.3 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB) FOR OUTDOOR USE

- A. When TGB are located outdoors, all specs for indoor used TGB shall be followed with the exception of the construction material. The TGB for outdoor use shall be made of galvanized steel.

2.4 FLEX CONDUCTOR, ONE-HOLE, LONG BARREL WITH WINDOW LUG

- A. All BCs shall be terminated in a flex conductor, one hole, long barrel with window lug when a two hole connector is not possible to be used because receiving equipment does not support the two holes. All lugs shall be selected to match the size of the conductor being used. Other types of terminations such as screw type connectors are not accepted. A flex conductor, one hole, long barrel with window lug shall never be used to terminate TBB
- B. The flex conductor, one hole, long barrel with window lug shall have the following specification:
1. Finish: Thin platted
 2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
 3. Stud hole size: 1/4"
 4. Barrel type: Long barrel > 1"
 5. Termination type: crimp type
 6. Angle: straight or angled if installation space is limited.
 7. Listing: UL listed and tested to 35 KV and 90°C
- C. Approved manufacturers: Panduit, Thomas & Betts or approved equal.

2.5 FLEX CONDUCTOR, TWO HOLE, LONG BARREL WITH WINDOW LUG

- A. Flex conductors, two hole, long barrel with window shall be used with TBB and BCs to provide a good bond. All lugs shall be selected to match the size of the conductor being used. Other types of termination are not accepted.
- B. The flex conductor, two hole, long barrel with window lug shall have the following specification:
1. Finish: Thin platted

2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
 3. Stud hole size: ¼"
 4. Hole spacing: to match spacing of pre-drilled holes in ground bar or equipment.
 5. Barrel length: long barrel > 1"
 6. Termination type: crimp type
 7. Angle: straight or angled if installation space is limited.
 8. Listing: UL listed and tested to 35 KV and 90°C
- C. Flex conductors, two hole, long barrel with window shall be used with BCs in the following cases:
1. Bonding two sections of pathways such as sections of tubular runways or cable trays.
 2. Bonding a BC or a TBB to a TGB or TMGB
 3. Bonding to equipment that requires two holes for bonding.
- D. Approved manufacturers:
1. Panduit,
 2. Thomas & Betts or
 3. approved equal.

2.6 HTAP CONNECTOR

- A. When a BC is required to be bonded to another BC of same or different size the only approved method of bonding is with HTAP style crimp connectors. Screw type connectors, wire nuts or any other method are not acceptable. The specifications of the HTAP connectors are:
1. Finish: Thin plated
 2. Cable types: designed to work with Flexible, Extra-Flexible, and Code Stranded Copper Conductors.
 3. Tap grooves: installer to select HTAP connector based on size of BCs and quantity of BCs to be bonded.
 4. Slots: The HTAP connector shall have a lot to support the unit to the bonding conductors with nylon cable ties for initial support before crimping.
 5. Termination type: crimp type
 6. Listing: UL listed and tested to 600V
- B. Approved manufacturers:
1. Panduit,
 2. Thomas & Betts or
 3. approved equal.

2.7 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- A. Telecommunications bonding backbones shall be provided as indicated in the design documents. TBBs shall be insulated copper stranded conductors with a wire gauge dictated by the length of the cable. The TBB shall be sized according to the table below:

TBB LENGTH LINEAR M (FT)	TBB SIZE (AWG)
-----------------------------	----------------

Less than 4 (13)	6
4- 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8– 10 (27 – 33)	2
10– 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20-26 (67-84)	3/0
26-32 (85-105)	4/0
32-38 (106-125)	250 kcmil
38-46 (126-150)	300 kcmil
46-53 (151-175)	350 kcmil
53-76 (176-250)	500 kcmil
76-91 (251-300)	600 kcmil
Greater than 91 (300)	750 kcmil

- B. Once a TBB has been sized with a particular gauge, any extensions of such backbone shall not be done with a wire gauge smaller than the previous run regardless of distance.

2.8 BONDING CONDUCTOR (BC)

- A. Bonding conductors shall be used to bond equipment and raceways to the telecommunications grounding infrastructure. The specifications of the BC are:
1. Conductor Size: use the chart above for TBB to estimate the size of the bonding conductor. BC shall be no smaller than an AWG-6. For projects with R56 Grounding compliance, BC shall be no smaller than AWG-2.
 2. Material: copper stranded conductors.
 3. Insulation: Use non-insulated conductors only under raised floor spaces. Insulation color shall be green with a yellow stripe.
- B. Pre-fabricated BCs or field made BCs are acceptable.
- C. Both ends of a BC shall be terminated in long barrel lugs.

2.9 RAISED FLOOR BONDING CLAMP

- A. Raised floor bonding clamps shall be used to bond BCs under the raised floor to raise floor pedestals. The specifications of the raised floor bonding clamp shall be:
1. Construction: solid metal device
 2. Bonding of BCs: The device used to bond the BCs shall be a split screw copper bolt sized to match the size of the BCs being bonded
 3. Bonding of raised floor pedestals: The device shall include an adjustable clamp to bond the pedestal. The installer of this system is responsible for selecting the size of the clamp to match the size and shape of the pedestal provided for this project.
 4. Listing: UL listed

- B. Approved manufacturers:
 - 1. Panduit,
 - 2. Thomas & Betts or
 - 3. approved equal.

2.10 MESH COMMON BONDING NETWORK (MCBN)

- A. A Mesh Common Bonding Network (MCBN) shall be provided under all raised floor spaces in the project. The MCBN is basically a grid of non-insulated BCs running under the raised floor. The MCBN shall include a loop around the perimeter of the raised floor. The details of the construction of the MCBN shall be:
 - 1. Size of conductors: Conductors shall be sized using the table provided in this specification to size the TBB but conductors shall not be larger than 1/0 AWG.
 - 2. Spacing of the grid: The grid of conductors shall have a spacing no longer than 10'. Below each row of cabinets, racks or consoles there shall be a conductor part of this grid.
 - 3. Continuous conductors: Each grid line of conductors shall be a continuous conductor without any splices.
 - 4. Aligning: All grid lines shall be adjacent to the raised floor pedestals to be able to bond the pedestals.
 - 5. Elevation: All conductors part of the MCBN shall not be resting or touching the floor slab. They should be mounted around half of the height of the raised floor pedestals.
 - 6. Bonding: Bonding shall be provided to the MCBM at the following locations:
 - a. Each pedestal with one or more BCs adjacent to it, shall be bonded using a raised floor bonding clamp.
 - b. All metal equipment under the raised floor shall be bonded to the MCBN such as cable trays or conduits.
 - c. All ground bars above the raised floor and inside the same room shall be bonded to the MCBM with a BC of equal size as the largest conductor in the MCBN
 - 7. Listing: All bonding equipment used for the MCBN shall be UL 467 listed.
- B. Racks, cabinets and consoles above the raised floor shall be individually bonded to the MCBN with a non-insulated BC, if space below raised floor is being used for air handling. An insulated BC shall be used if the space below the raised floor is not being used for air handling.

2.11 LABELS FOR TELECOMMUNICATIONS GROUNDING INFRASTRUCTURE

- A. Installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES.

- A. General: Specification section 260526 applies to work of this section. Installation requirements specified herein takes precedence over specification section 260526.
- B. General: All installation requirements indicated in specification section 270010 shall be followed.

- C. **PROTECTION.** The TBBs and BCs shall be installed and protected from physical and mechanical damage.
- D. **GALVANIC CONTINUITY.** The TBBs and BCs shall be continuous and routed in the shortest possible straight line path.
- E. **BONDING SECTIONS OF TUBULAR RUNWAY OR CABLE TRAY.** A bonding jumper with a two hole long barrel lug with window at both ends shall be used to bond adjacent sections of cable tray or tubular runway. The jumper cable shall be no less than 8 inches in length and shall be made of stranded copper cable AWG-6.
- F. **CRIMPING.** All lugs shall be crimped with the proper die for the size of lug being used.
- G. **PAINT REMOVAL.** Paint shall be removed before attaching any BC to an equipment with paint in the surface, such as tubular runway and racks, if no ground lug is available in the equipment.
- H. **SPLICING.** The TBBs and BCs shall be installed without splices. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located within telecommunications spaces. Joined segments of a TBB or BC shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage.
- I. **BONDING TO ELECTRICAL PANELS.** The TGB or TMGB shall be as close to the electrical power panel as is practicable and shall be installed to maintain clearances required by applicable electrical codes. The electrical power panel bus or the panel enclosure feeding telecommunications equipment racks/cabinets shall be bonded to the TGB or TMGB.
- J. **BONDING TO BUILDING STEEL.** All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.
- K. **LUG SCREWS.** All connections from lugs to ground bars or grounding equipment shall be done with metal screws with nuts and compression washers. Connections made with metal self tapping screws will not be allowed.
- L. **BONDING PROTECTOR BLOCKS.** All primary or secondary building entrance protectors' blocks shall be bonded to the nearest TMGB or TGB with a BC. A minimum of 300 mm (1 ft) separation shall be maintained between this insulated conductor and any dc power cables, switchboard cable, or high frequency cables, even when placed in rigid metal conduit or EMT.
- M. **BONDING OUTSIDE PLANT CABLES.** When the outside plant cables in the Telecommunications Entrance Facility room incorporate a cable metallic shield (armor) isolation gap, the cable metallic shield on the building side of the gap shall be bonded to the TMGB or TGB or the rack/cabinet or the rack's vertical ground bar (if available).
- N. **BONDING BACKBONE CABLES.** Where backbone cables (fiber or copper) incorporate a shield (armor) or metallic member, this shield or metallic member shall be bonded to the TMGB or TGB or rack/cabinet or the rack's vertical ground bar (if available).
- O. **BONDING HORIZONTAL CABLES.** When shielded horizontal cable is used and terminated in patch panels, each patch panel needs to be bonded to the telecommunications grounding

systems. A BC shall be used between each patch panel and the rack rails of the rack/cabinet or the rack's vertical ground bar (if available).

- P. INTENDED USE OF TBB OR BC. The TBB or BC is not intended to serve as the only conductor providing a ground fault current return path. The intended function of the TBB or BC is to equalize potential differences between telecommunications systems.
- Q. INSTALLATION OF TBBs INSIDE TELECOMMUNICATIONS SPACES. When TBBs are run inside telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs inside telecommunications spaces can be made of PVC and shall be sized and supported as required by NEC.
- R. INSTALLATION OF TBBs OUTSIDE TELECOMMUNICATIONS SPACES. When TBBs are run outside of telecommunications spaces they shall be protected from damage by running them inside conduit. Conduit to protect TBBs outside telecommunications spaces shall be EMT or RMC. To avoid an electromagnetic choke effect in this conductor, each end of the conduit used to protect the TBB shall be bonded to the TMGB or TGB at each end. Conduit used for protection of TBBs shall be sized and supported as required by NEC.
- S. HALO GROUND SYSTEM. For room with R56 grounding requirements, a halo ground shall be provided around the room. This halo ground is composed of a AWG-0 uninsulated stranded copper conductor, installed 6" below the ceiling, going around the complete perimeter of the room and one end bonded to the TGB in that room. This conductor shall be separated from the wall with 6" plastic stand offs. All metal structures or parts around the room, such as door frames and windows, mechanical cooling equipment, conduit sleeves, etc. shall be bonded to this conductor with a compression connector.
- T. RACK/CABINET BONDING. All racks/cabinets in the project shall be bonded to the nearest TMGB or TGB inside the room. All rows of rack/cabinets shall be bonded together by a single AWG-2 conductor coming from the nearest TMGB or TGB inside the room. This bonding conductor shall be insulated and run above the racks in the side of the cable tray system, going above the racks, supported by a hanger external to the cable tray. At each rack a bonding jumper (AWG-6) shall be provided and terminated to the rack manufacturer's recommended lug for bonding the rack/cabinet. The bonding jumper shall be connected to the AWG-2 conductor by means of an HTAP connector, protected with heat shrink material. When the project requires R56 grounding compliance, the bonding jumper shall be upsized to an AWG-2 and a vertical ground bar shall be provided for each rack/cabinet from top to bottom of each rack/cabinet. This ground bar shall be the termination point for the bonding jumper for each rack and shall also bond the manufacturer's approved grounding lug in the rack/cabinet to the ground bar.
- U. RACK/CABINET BONDING OUTSIDE OF TELECOM ROOMS. Racks/cabinets outside of telecom rooms shall be bonded to the nearest electrical ground with a BC.
- V. LABELING: All labeling systems for telecommunications grounding infrastructure shall be in compliance with the ANSI/TIA-606-C standard. At a minimum, the following elements shall be labeled in the telecommunications grounding system:
 - 1. All TMGB or TGB, with a unique identifier located in the wall near the unit, not on the ground bar.
 - 2. All TBBs in the project with a unique identifier at each termination point of each TBB. The label in one side of the cable shall indicate the termination location of the other side of the cable.

3. BC for rows of racks with a unique identifier at both ends of the cable
 4. BC for surge protectors with a unique identifier at both ends of the cable
- W. ADDITIONAL LABELING. All BCs bonding rows of racks/cabinets and TBBs shall have additional to the identification marker a yellow printed wrap around tag installed close to the bonding point strap to the cable jacket with a flame retardant cable tie. This tag shall have the following wording in green letters: "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER".

3.2 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

- A. See specification section 270010 for as built and close out information requirements.

END OF SECTION 270526

SECTION 270528 - RACEWAYS FOR TECHNOLOGY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Section 260533 - Raceway Systems, apply to work of this Section. Specifications described herein take precedence over Section 260533.
- C. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270526 Grounding and Bonding for Telecommunications Systems

1.2 DESCRIPTION

- A. General: Furnish and install complete with all accessories a Pathways and Spaces infrastructure for supporting of Structured Cabling System (SCS) and housing of technology equipment. The goal of the project is to provide a reliable architecture of the building that shall serve as a support for transport of data, voice telephony, security and audio/visual cabling throughout the building from designated demarcation points to places located at various wall, floor, ceiling, column, room and other locations as indicated on the contract drawings and described herein.
- B. General: For pathways the system shall utilize a combination of conduit, cable tray and supports for vertical and horizontal cabling support. Pathways shall be provided and located as shown and in the quantities indicated on the drawings. Pathways shall terminate in rooms or closets using approved fasteners and termination hardware and bushings and shall be reamed to eliminate sharp edges. All Pathways shall be identified at all locations.
- C. All installers should anticipate that all products and installation procedures shall comply with the ANSI/TIA-569-E requirements at a minimum.
- D. General: Installation of the raceways for communications shall be a complete system including all supports and hangers as required per contract documents and manufacturer's installation guidelines.
- E. Support: All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels. Do not install any devices supported by ceiling tiles.
- F. Installation: The Installer shall layout and provide his work in advance of the laying of floors or walls, and shall provide all sleeves that may be required for openings through floors, walls, etc. Where plans call for conduit to be run exposed, provide all inserts and clamps for the supporting of conduit.

- G. Pull Strings: Provide pull strings in all raceways. Pull strings shall be nylon and shall be impervious to moisture. Pull strings installed in one (1) inch and smaller conduits shall have a tensile strength of not less than 30 lbs. Pull strings installed in conduits larger than one (1) inch shall have a tensile strength not less than 200 lbs.
- H. Directional boring might be required in the drawings or the installer might choose this method as the way to install underground conduit on this project. In either case, the installer shall comply with the requirements indicated here for directional boring.
- I. If at the time of bid and underground locate survey is not available, the installer shall include in the pricing the cost of this survey. No directional boring will be allowed without such survey being completed.

1.3 INSTALLER QUALIFICATIONS

- A. General: The installer selected for the Project must be BICSI certified installer and certified by the manufacturer for the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning the Project.
- B. General: The Installer directly responsible for this work shall be a " Pathways and Spaces for Structured Cabling System Installer (PS-SCS) " who is, and who has been, regularly engaged in the providing and installation of commercial and industrial pathways and spaces for telecommunications wiring systems of this type and size for at least the immediate past five years. Any sub-Installer who will assist the PS-SCS installer in performance of this work, shall have the same training and certification as the PS-SCS installer.
- C. Certification: The installer's Project Manager shall possess a current and in good standing BICSI Registered Communications Distribution Designer (RCDD) certificate. All shop drawings submitted by the installer shall bear the RCDD's seal.
- D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and have personnel who are adequately trained in the use of such tools and equipment.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: Substitutions are allowed for all components of the systems under this specification sections as long as all requirements for substitutions indicated in specification section 270010 are followed.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. General: The PS-SCS installer shall provide no later than 30 days after contract award the following information:

1. Proof of Installer's qualifications per paragraph 1.03.
2. Cut sheets of all products to be used for the project, highlighting in particular the precise product to be used in each case, when multiple devices are indicated in the cut sheet. At a minimum the following devices shall be submitted with this specification section:
 - a. Supporting devices (j-hooks) if allowed in the project. See part 3 of this specification.
 - b. Cable tray system with accessories
 - c. Runway cable tray system with accessories.
 - d. Plywood
 - e. Trough wall/floor firestop system
 - f. Innerduct
 - g. Detectable tape
 - h. Communications vaults
 - i. Conduit waterfalls
 - j. Fire stop system (for small penetrations)
3. Drawings indicating precise location and type of all support for cable tray or ladder tray systems in all areas where they will be used.
4. For all communication vaults, drawings shall be prepared indicating conduit penetrations on each side of each vault. Vaults shall be labeled to indicate their correct location in the site plan.
5. Pre-cast communications vaults shall be submitted with load calculations signed and sealed by a professional engineer.
6. For any directional boring runs, the installer shall provide a drawing indicating all underground locate surveys and the proposed routing of the conduit as well as proposed depth.

1.6 WORK EXTERNAL TO THE BUILDING

- A. General: Any work external to the confines of this building as shown on the drawings shall be governed by provisions of this specification.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. All conduits as indicated in Section 26

2.2 TELECOMMUNICATIONS OUTLET BOX

- A. Telecommunication outlet electrical boxes shall be used to make terminations to limited energy systems described in Division 27 and Division 28 specifications. Telecommunications outlet boxes shall have the following specifications:
 1. Material: Steel, 0.6858mm. thickness (minimum) with galvanized zinc coating, 0.013mm. (minimum) thickness on both sides of bracket
 2. Construction: Cleanly punched knockouts, welded at 8 points (minimum) with softened edges (no sharp edges).
 3. Size (HXW): 4"X4" [4-11/16" X 4-11/16"] [5"X5"]

4. Depth: 2-1/8" [2-7/8"]
5. Knock outs: At least one of this dimension: 1" [1-1/4"]
6. Listing: UL or ETL

- B. Telecommunications outlet electrical boxes shall be provided with the appropriate 1 gang or 2 gang rings selected for the proper thickness of the drywall in all areas. Standard telecommunications outlets shall use 1 gang ring, but design documents might indicate the use of 2 gang rings in selected areas.
- C. Knockouts in telecommunications outlet boxes shall not be field punched.
- D. Basis of design: Raco, Steel City, Randal Industries Inc,

2.3 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

- A. HDPE pipe shall be used for all directional boring applications, or it can also be used for open trench applications. HDPE pipe shall comply with the following manufacturing standards:
 1. ASTM D 3035 Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
 2. ASTM D 2239 Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
 3. ASTM F 2160 Solid wall High Density Polyethylene (HDPE) Conduit based on Controlled Outside Diameter (O.D.)
 4. NEMA TC-7 Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.
- B. HDPE pipe shall be manufactured from a suitable thermoplastic polymer conforming to the minimum standard of PE334420E/C as defined in ASTM D3350. The resin properties shall meet or exceed the values listed below for HDPE pipe:

ASTM Test	Description	Values HDPE
D-1505	Density g/CM 3	0.941 - 0.955
D-1238	Melt Index, g/10 min Condition E	0.05 - 0.50
D- 638	Tensile strength at yield (psi)	3000 min.
D-1693	Environmental Stress Crack Resistance Condition B,F 20	96 min.
D-790	Flexural Modulus, MPa (PSI)	80,000 min.
D-746	Brittleness Temperature	-75°C

- C. Design selection: The HDPE pipe used in this project shall be Rib/Smooth – Ribbed Interior and Smooth Exterior wall. Pipe shall be available in multiple colors, non lubricated and shall include a factory installed 1,800 lbs polyester pull tape. HDPE pipe walls shall be in compliance with SDR 7 - ASTM D3035 specifications and shall have footage markings.
- D. Approved manufacturers: Carlon Industries or approved equal.

2.4 WIREWAYS

- A. General: Wireway shall be sized as shown on drawings, NEMA 1, lay-in type. Wireway sides and bottom shall contain no knock-outs unless shown otherwise on the drawings. The Installer shall punch holes required. The cover shall be hinge type with quarter turn fasteners to hold cover shut. Covers and bodies shall be 16 gauge steel. Wireway shall be as manufactured by Hoffman Engineering Company, Square "D" or Steel City.

2.5 SUPPORTING DEVICES

- A. Hangers: Hangers shall be made of durable materials suitable for the application involved. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing, or approved suitable preservative methods.
- B. Non-continuous cable supports (j-hooks) shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed.
- C. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
- D. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
- E. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
- F. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.
- G. Anchoring: Insert anchors shall be installed on concrete or brick construction, with hex head machine screws. Recessed head screws shall be used in wood construction. An electric or hand drill shall be used for drilling holes for all inserts in concrete or similar construction. Installed inserts, brick, shall be near center of brick, not near edge or in joint. Drilled and tapped, and round head machine screws shall be used where steel members occur. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal, or accepted substitution. Gunpowder or lead set anchors are not permitted.
- H. Accessories: Non-continuous support systems shall be provided with the adequate mounting accessories depending on the location where the support will be installed, like beam clips, flange clips, C and Z purlin clips.
- I. Accepted manufactures; Erico or Panduit.

2.6 CABLE TRAY AND FITTINGS (BASKET TYPE)

- A. General Description: Basket type cable tray system is to be constructed of welded steel wire mesh with continuous safety edge wire lip. Provide mesh system permitting for continuous ventilation of cables and maximum heat dissipation.

- B. Materials: Carbon Steel: Cable management system to be manufactured from high strength minimum 6 gauge steel wires. Wire to be welded and bent prior to surface treatment.
- C. Finishes: Electro-plated zinc Galvanizing: Electrodeposited zinc coating applied to an average thickness of 0.7 mils to 0.8 mils. **Hot Dip Galvanizing: Hot dip galvanizing in molten zinc bath providing an average coating thickness of 2.4 mils to 3.2 mils.** Equipment Gray: Powder painted surface treatment using ASA 61 Gray Polyester coating or as shown on the drawings.
- D. Cable tray dimensions: as shown on the drawings.
- E. Fittings: Cable tray fittings to be field manufactured from straight sections through use of hardware and instructions recommended by Manufacturer. Provide drop-off, 90° kits and tees as required using manufacturer fabricated products and installation guidelines.
- F. Installation: Cable tray system to be installed using splice connectors, and support components as recommended by the Manufacturer.
- G. Loading Cable tray system to be installed and supported per NEMA VE-2 and Manufacturer's suggested span load criteria.
- H. The cable tray system shall be UL listed and classified as a continuous bonded tray system providing a continuous grounding path. Cable tray system is required to be tested for grounding adequacy per NFPA 70B, Chapter 18 with a maximum allowable resistance of 1 ohm.
- I. Approved Manufacturers: Wiremold, Cablofil, Snake Tray, B-line, WBT or Chatsworth.

2.7 CABLE TRAY AND FITTINGS (LADDER TRAY TYPE)

A. CABLE TRAY SECTIONS AND COMPONENTS

- 1. General: Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
- 2. Materials and Finish: Material and finish specifications for each cable tray type are as follows:
 - a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
 - b. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.
 - c. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray. All hot-dip galvanized after fabrication steel cable trays must be returned to point of manufacture after coating for inspection and removal of all

icles and excess zinc. Failure to do so can cause damage to cables and/or injury to installers.

- d. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with Type 316 stainless steel welding wire.

B. TYPE OF TRAY SYSTEM

1. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced [6] [9] [12] [18] inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200 pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.
2. Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4 inch rectangular holes punched along the width of the bottom.
3. Solid bottom trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inch and shall be spaced 6 inches on center.
4. Tray Sizes shall have [3] [4] [5] [6] inch minimum usable load depth, or as noted on the drawing.
5. Straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard [10] [12] [20] [24] foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
6. Tray widths shall be as shown on drawings.
7. All fittings must have a minimum radius as the width of the tray.
8. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
 - a. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum cable tray is to be used outdoors then hardware shall be Type 316 stainless.
 - b. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Each splice plate shall be attached with four ribbed neck carriage bolts with serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.
9. Splice plates shall be furnished with straight sections and fittings.
10. Cable Tray Supports: Shall be placed so that the support spans do not exceed maximum span indicated on drawings. Supports shall be constructed from 12 gauge steel formed

shape channel members 1-5/8 inch by 1-5/8 inch with necessary hardware such as Trapeze Support Kits. Cable trays installed adjacent to walls shall be supported on wall mounted brackets. All types of supports shall be factory made supports supplied by the same manufacturer of the cable tray system as recommended for the type of cable tray selected.

11. Trapeze hangers supports shall be supported by 3/8 inch (minimum) diameter rods.
12. Barrier Strips: Shall be placed as specified on drawings and be fastened into the tray with self-drilling screws.
13. Accessories - special accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, barriers, etc.

C. **LOADING CAPACITIES**

1. Cable tray shall be capable of carrying a uniformly distributed load of 109 lbs. /ft. on a 12 foot support span with a safety factor of 1.5 when supported as a simple span and tested per NEMA VE1 Section 5.2. In addition to the uniformly distributed load the cable tray shall support a 200 lb. concentrated load at mid-point of span and centerline of tray. Load and safety factors specified are applicable to both side rails and rung capacities.

- D. Approved Manufacturers: B-line, Chatsworth or approved equal.

2.8 **TUBULAR RUNWAY CABLE TRAY AND FITTINGS**

- A. Materials: ASIM A36 steel bar.
- B. Finish: Baked Powder painted surface treatment using Polyester coating.
- C. Finish color: to match equipment cabinet finish color. See specification section 271000.
- D. Cable management tray width: as shown on the drawings.
- E. Fittings: Cable management fittings and hardware recommended by Manufacturer. Provide drop-off, 90° and tees as required for the equipment served and support of the cable. Provide at least one large radius drop off for each rack/cabinet in the project.
- F. Installation: Cable management system to be installed using support components as recommended by the Manufacturer.
- G. Loading: Cable management system to be installed and supported per Manufacturer's suggested span load criteria.
- H. Approved Manufacturers: B-line, GS Metals, Chatsworth.

2.9 **PLYWOOD BOARDS IN TELECOMMUNICATION ROOMS**

- A. Plywood Backboard: Backboards shall be installed in each TR and the MTR on walls to a height of 8' AFF or as shown on the drawings. Rooms shall have walls covered as shown on the drawings

- B. Acceptable options for plywood boards are:
 - 1. ¾" AC Grade **fire rated** plywood painted with two coats of fire retardant paint in both sides and on the edges.
 - 2. Pre-manufactured plywood system for telecommunications such as ReadySpec by Pathways and Spaces Inc.
- C. Other specifications:
 - 1. All imperfections and voids shall be filled, sealed and sanded prior to being primed and painted.
 - 2. Fire retardant coating shall be tested to UL723, "Test for surface burning characteristics of building materials."
 - 3. Paint color shall be grey, white or blue.
 - 4. Fire retardant plywood shall be clearly labeled with the name of the Backboard Manufacturer, UL Classification of the Fire Retardant Coating, NFPA 255 Coating Flame Spread Index Class and the APA Grade of the plywood.
 - 5. Plywood shall be installed with best side out.

2.10 THROUGH WALL/FLOOR FITTING FIRE STOP SYSTEM

- A. General. These devices covered under this specification are firestop devices for use in through-penetration firestop systems, which are used to maintain the fire rating of the wall or floor, as well as to route and protect power and/or communications cable distribution for commercial, educational, healthcare, government, institutional, industrial and utility needs.
- B. Classification and use: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4 1/2" (114mm) thick reinforced lightweight or normal weight (100-150 pcf) (1600-2400 kg/m³). The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.
- C. Materials:
 - 1. Box: The fire stop device box shall be constructed of 16 gage G90 steel.
 - 2. Intumescent block: The fire stop device intumescent block shall be constructed of a graphite base material with expansion starting at 375° F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
 - 3. Adjustable doors: the fire stop device shall have doors or other system which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gage G90 steel with no. 10-32 screws use to adjust opening size.
 - 4. Heat shield: For retrofit applications where an existing in-wall conduit extends out from the wall more than 7/8" [22mm], a UL listed Heat Shield must be used in order to maintain UL Fire Classification. The firestop device is then installed onto the heat shield
 - 5. Split conduit and wall plate: For retrofit applications where no conduit is installed in the wall to protect existing cables, a split conduit assembly should be used to protect cables. After installing the split conduit within the wall, a wall plate should be installed to cover

any irregularly shaped hole cut in the wall. The firestop device is then installed onto the conduit.

- D. Retrofit: For retrofit applications the unit shall be a split case system that allows the unit to be installed over existing cables.
- E. Sizes: the fire stop device shall be available for two (2) inch and four (4) inch trade size EMT conduit.
- F. Finish: the fire stop device shall be available in safety yellow or orange powder coat, custom colors and an unpainted galvanized finish.
- G. Design selection: Wiremold FlameStopper, STI EZpath or approved equal

2.11 INNERDUCT (REGULAR)

- A. Flexible raceway system also referenced in the design documents as regular innerduct or innerduct shall be provided in locations indicated in design drawings. The innerduct type shall be selected according to the environment where it will be installed, use HDPE innerduct only outdoors, use plenum or riser rated innerduct indoors. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.
- B. For plenum rated applications, the specifications of the innerduct shall be:
 - 1. Material: White or orange Kynar PVDF Resin, a fluoropolymer compound.
 - 2. Listing: Innerduct shall be listed to UL 224, listing shall be printed in the product.
 - 3. Marking: Footage shall be sequentially marked.
 - 4. Configuration: corrugated type.
 - 5. Pull line: built in 900 lb rated tape.
 - 6. Size: Shall be available in 3/4" through 2" diameters.
- C. For riser rated applications, the specifications of the innerduct shall be:
 - 1. Material: Orange polyvinyl chloride (PVC).
 - 2. Listing: Innerduct shall be listed to UL 224, listing shall be printed in the product.
 - 3. Marking: Footage shall be sequentially marked.
 - 4. Configuration: corrugated type.
 - 5. Pull line: built in 900 lb rated tape.
 - 6. Size: Shall be available in 3/4" through 2" diameters.
- D. For outdoor applications, the specifications of the innerduct shall be:
 - 1. Material: High Density Polyethylene (HDPE).
 - 2. Listing: None.
 - 3. Marking: Footage shall be sequentially marked.
 - 4. Configuration: corrugated type.
 - 5. Pull line: built in 1,800 lb rated tape.
 - 6. Size: Shall be available in 3/4" through 2" diameters.
- E. All inner ducts shall be provided with couplings and accessories suitable for the environment where they will be installed.

- F. Design selection: products by Carlon or approved equal.

2.12 INNERDUCT (FABRIC TYPE)

- A. When indicated in the design drawings, high capacity innerduct made of fabric shall be used inside telecommunication raceways to facilitate the pulling of telecommunication wires in those raceways. The fabric type Innerduct (also referenced as textile innerduct) shall have the following specifications:
 - 1. Material: White Polyester and Nylon resin polymer
 - 2. Standard Outdoor Textile Innerduct: Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape.
 - 3. Indoor Textile Innerduct (Riser-listed): Micro (33mm), 2-inch, 3-inch and 4-inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications.
 - 4. Plenum-Listed Textile Innerduct: Micro (33mm), 2-inch and 3-inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces.
- B. The installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the installer is not sure what kind of environment is present in the project, the installer shall price plenum rated materials.
- C. Design selection: Products manufacturer by The Maxcell Group or approved equal. Approved equal shall be only of the fabric type innerduct.

2.13 DETECTABLE TAPE

- A. A detectable tape shall be installed above all underground conduit at a minimum depth of 18" or as shown on the drawings. The detectable warning tapes shall be constructed with a solid aluminum foil core with a minimum thickness of 5 mils and 3" wide. The detectable warning shall have printed diagonal warning stripes conform to APWA color recommendations and bold, black legends identify what type of utility line is buried below. All detectable tapes used for this shall be labeled "fiber optics buried below".
- B. Design selection: Detectable tape from Carlon, Stranco, Ind., Terra Tape or approved equal.

2.14 COMMUNICATIONS VAULT (POLYMER CONCRETE)

- A. In ground communication boxes also referenced in this document as communications vaults (polymer concrete) shall have the following specifications:
 - 1. Construction Material: Precast Polymer Concrete.
 - 2. Listing: UL listed enclosure, tested to ANSI/SCTE 77
 - 3. Box vertical design load: 22,500 lbs.
 - 4. Box vertical test load: 33,750 lbs.
 - 5. Box lateral design load: 800 lbs/sq. ft.
 - 6. Box lateral test load: 1,200 lbs/sq. ft.

7. Box dimensions: as indicated in design drawings.
 8. Box bottom: open bottom
 9. Holes for conduit: holes for conduit shall be cut at the factory and shall not cover more than 25% of the side of the enclosure. All sides of the box shall have holes for conduits, even though conduits might not be shown for all sides in the floor plans. No less than two holes for standard 4" conduit shall be at all sides. All unused holes shall be plug with plastic caps.
 10. Cover ANSI TIER: 22
 11. Cover logo: "Communications"
 12. Cover screws: two (2) tamper resistant penta head screws
 13. Cover accessories: two (2) 7" long cover hooks made of electroplated steel.
- B. Design selection: Hubbell Quazite PG style box with HH series cover and accessories or approved equal. Approved equals shall comply with all specifications listed above including construction material.

2.15 COMMUNICATIONS VAULT (PRECAST CONCRETE)

- A. In ground communication boxes also referenced in this document as communications vaults (precast concrete) shall have the following specifications:
1. Construction Material: concrete 5000 psi @ 28 days
 2. Rebar: ASTM A 615 grade 60 rebar
 3. Mesh: Welded wire fabric ASTM A185 grade 65
 4. Size: As indicated in design drawings
 5. Design: comply with local building code for reinforced concrete
 6. Loads: Dead load: concrete 150 PCF
Earth cover – 120 PCF
Lateral Earth pressure on walls: Equivalent fluid pressure above water table + 36 PSF per foot of depth. Equivalent pressure below water table + 81.4 PSF per foot of depth.
 7. Live load: AASHTO HS20-44. 32,000 lbs. rear axle loading.
- B. The cover and frame for the communications vault shall have the following specifications:
1. Style: Hatch type [galvanized cover] [concrete lid] [concrete lid with ring and cover].
 2. Cover design (for hatch type or galvanized cover): Hot dip galvanized after fabrication built to an H20 rating for non roadway applications with dual doors.
 3. Cover design (for concrete lid with ring): 30" diameter cast or ductile iron, built to an H20 rating up to 150 KIO.
 4. Lettering: Covers shall be label as "Telecommunications"
- C. All communications vault shall be provided with the following accessories:
1. Embedded lifters made of galvanized steel
 2. All communications vaults with a concrete lid and ring shall be provided with a grade ring or riser made of concrete to bring the cover up to grade level. Precast concrete grade rings and cones shall comply with ASTM C 478, except that the wall thickness shall be 6 inches minimum. Provide interlocking keyways on rings and cones. Provide cones with cast in place inserts for the vault frame.
 3. Embedded pulling irons made or carbon steel galvanized.
 4. Two lengths of embedded unistrut (galvanized) for bolting equipment on 2 opposite walls of the vault.

- D. Precast vault construction shall be in the form of monolithic walls or horizontal wall sections. Do not use panel walls.
- E. Minimum wall thickness shall be 6 inches. Design knockout wall panels to accommodate loading pressures defined above.
- F. Design and construct vaults to be watertight when subjected to groundwater over the entire height of the vault.
- G. Provide openings in precast vaults for piping and access. Provide cast in place inserts in the roof slab and end walls at the locations as shown on the Drawings. No field coring of openings is allowed.
- H. When communications vault are made of different sections, they shall be sealed and bonded with a double layer of plastic sealing compound and make watertight. Plastic sealing compound shall comply with Federal Specification SS-S-00210. Fill with mortar all recesses, lifting inserts, or other cavities not filled with plastic sealing compound. Mortar shall comply with ASTM C 387, Type S.

2.16 CONDUIT WATERFALLS

- A. All 4" EMT terminations with communication cable entering/exiting the conduit from a cable tray (or tubular runway) system and the vertical separation between raceways is larger than 7" shall be fitted with a device to control the bend radius of the communication cable to a minimum of a 4" radius. The device to control the bend radius shall be called a conduit waterfall and must comply with all National Electrical Code requirements and TIA/EIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, be UL 94V-0 approved to reduce the spread of flame, and be approved by UL for use in air handling spaces. The device to provide bend radius control must support a static load of 40 lbs. (177.9 N) and have a fastening device that allows for incremental adjustments to conform to variances in conduit diameters.
- B. Device quantities are not indicated in the drawings but the PS-SCS shall use all 4" conduits and sleeves indicated in the drawings to estimate the quantities of waterfalls to be used in the project.
- C. Basis of design: Panduit CWF 400 or approved equal.

2.17 FIRE STOP SYSTEMS (FOR SMALL PENETRATIONS)

- A. General: Fire stop system shall be selected by the PS-SCS installer as to comply with the following requirements:
 - 1. Selected system shall be UL listed for the condition on which it will be installed. These conditions include: wall/slab type (masonry, drywall, etc), hour rating, and accessibility type.
- B. Acceptable systems: caulk based products or firestop grommets by STI or equal.

2.18 EXPANSION FITTINGS

- A. Installation: Provide expansion fittings in each conduit run wherever it crosses an expansion joint. Install the fitting on one side of the joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.
- B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.
- C. Length: Provide expansion fittings in straight conduit runs above ground which are more than one hundred (100) feet long.
- D. Flex conduit is not allowed to be used as expansion fittings.
- E. Design drawings do not show symbols for expansion fitting. The installer shall look at the structural and architectural drawings for locations of expansion joints to determine the quantities of fittings required for the job.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. See additional requirements indicated in part 3 of specification section 270010.

3.2 INDOOR CONDUITS BELOW GRADE AND ABOVE GRADE

- A. BEND RADIUS. Conduits shall utilize long radius sweeps at all 90 degree transitions. The inside radius of a bend in conduit shall be at least six (6) times the internal diameter. When the conduit size is greater than two (2) inches, the inside radius shall be at least ten (10) times the internal diameter of the conduit. For fiber optic cable, the inside radius of a bend shall always be at least ten (10) times the internal diameter of the conduit
- B. ENCLOSURES USED AS CONDUIT BENDS. Enclosures such as junction boxes, handholes or communications vaults shall not be used to change direction of conduits, unless the enclosures are large enough to preserve the bend radius of the conduit as indicated in the point above. As an example, a junction box with 4" conduits entering in two adjacent sides of the enclosure should preserve a minimum of 40" radius between the closest conduits in the adjacent sides of the enclosure. It is required, that if the enclosure sizes don't meet this criteria, the conduit bends shall be done before entering the enclosure.
- C. ENCLOSURES FOR STRAIGHT PULLS. Enclosures such as junction boxes, handholes or communications vaults used in straight pulls, shall have a minimum length to allow for proper cable pulling. Enclosures with terminating conduits from 2" to 3" in size shall use enclosures with a minimum length of 24". Enclosures with terminating conduits of 4" in size shall use enclosures with a minimum length of 36". It is acceptable to use metallic wireways as junction boxes for straight pulls as long as they are installed with the cover accessible to the end user.

- D. **MAXIMUM DISTANCE BETWEEN JBOXES.** For indoor installation no section of conduit shall be longer than one hundred (100) ft or contain more than two (2) 90 degree bends between pull points or pull boxes are required. For outdoor installation no section of conduit shall be longer than six hundred (600) ft. or contain more than two 90 degree bends between pull points or pull boxes are required.
- E. **LABELING.** All indoor conduits 2" or larger shall be labeled at both ends when these conduit runs are continuous between two rooms and going through multiple walls or slabs. Labeling materials shall be as indicated in specification section 270010. Conduit sleeves 2" or larger penetrating just one wall is not required to be labeled.
- F. **PULL STRINGS;** All conduits for technology systems shall be installed with pull strings.

3.3 UNDERGROUND TELECOMMUNICATIONS DUCT LINES

- A. **Description:** Underground duct lines shall be of individual conduits. Conduits shall be encased in concrete where indicated on the plan drawings and duct bank sections. The conduit shall be of plastic, PVC Schedule 40, unless indicated or specified otherwise. The conduit used shall not be smaller than four (4) inches in diameter, inside, unless otherwise noted on the drawings.
- B. **The concrete encasement surrounding the duct bank shall be reinforced as shown and rectangular in cross-section, having a minimum concrete thickness of two (2) inches. Conduit shall be separated by a minimum concrete thickness of two (2) inches. The concrete work shall conform to Section on "Concrete". The top of the concrete envelope shall be not less than eighteen (18) inches below grade. Concrete shall be installed in a continuous pour to eliminate joints in the duct run.**
- C. **Duct lines shall have a continuous slope downward toward communication vaults and away from buildings with a pitch of not less than 0.125 inches per foot. Changes in direction of runs exceeding a total of ten (10) degrees either vertical or horizontal shall be accomplished by long sweep bends having a minimum radius of curvature of twenty five (25) feet, except that manufactured bends may be made up on one or more curved or straightened sections or combinations thereof. Manufactured bends shall have a minimum radius of forty eight (48) inches.**
- D. **Conduits.** Conduits shall terminate in end-bells where duct lines enter manholes or communications vaults. Provide four (4) to six (6) inch reducers as required. Separators shall be of pre-cast concrete, high impact polystyrene, steel or any combination of these. The joints of the conduits shall be staggered by rows so as to provide a duct line having the maximum strength. During construction partially complete duct lines shall be protected from the entrance of debris, such as mud, sand and dirt by means of suitable conduit plugs. As the duct line is completed, a testing mandrel not less than 13 inches long with a diameter 1/4 inch less than the size of the stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand or gravel; conduit plug shall then be immediately installed.
- E. **Conduit.** Plastic conduit, fittings and joints shall not have been stored in the sun or weather, in any excessively heated space, or unevenly supported during storage. Use and installation shall be in accordance with the National Electrical Code requirements for the installation of non-metallic rigid conduit. Plastic conduit shall be protected against the direct rays of the sun prior

to installation. Conduit shall be Carlon Type EB, Queen City Plastics, or accepted substitution. Conduit shall be U.L. listed and conform to NEMA Standard TC6 1972.

- F. Trench: Trenches for duct banks shall be completely dry before setting conduits or pouring concrete. Well pointing as required shall be provided if necessary to keep trench dry.
- G. Excavation: Backfilling shall be in layers not more than eight (8) inches deep, and shall be thoroughly tamped. The first layer shall be earth or sand, free from particles that would be retained on a 1/4 inch sieve. The succeeding layers shall be excavated material having stones no larger than would pass through a four (4) inch ring. The backfill shall be level with adjacent surface, except that in sodded or paved areas, a space equal to the thickness of the sod or paving shall be left.
- H. Finish: The surface disturbed during the installation of duct shall be restored to its original elevation and condition if not refinished in connection with site work.
- I. Plugging: All unused conduit openings shall be plugged or capped with a suitable device designed for the purpose; caulking compound shall not be used for plugging conduit openings.
- J. Stubs: Spare conduit stubs shall be capped and marked in the field and accurately dimensioned on the as-built drawings.
- K. Spacers: All conduit run underground, or stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel.
- L. Minimum burial depth: All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300.5 of the NEC except that the minimum cover for any conduit or duct bank shall be two (2) feet, unless otherwise indicated.
- M. Directional boring. For all applications requiring directional boring the following installation practices shall be followed.
 - 1. The installer shall select the directional boring equipment based on the length of the pulls, soil conditions, pipe size and pipe quantities.
 - 2. When multiple pipes are run, each pipe shall be a different color.
 - 3. Any pipe run less than 1,500 ft, shall be run as a single pull without splices.
 - 4. Any splices done to HDPE pipes shall be done with manufacturer's approved methods.

3.4 INSTALLATION OF COMMUNICATIONS VAULTS

- A. Excavating and backfilling for vaults. Perform earthwork as specified in Division 2. Provide 6-inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend 12 inches beyond the edges of the vault. After repairing the waterproofing, backfill and compact around the vault with structural backfill material. Excavated material may be used for structural backfill provided it conforms to the Standard Specifications for structural backfill material.
- B. Installing vaults and risers. Set each concrete vault section or riser plumb on a double layer bed of sealant at least 1/2-inch thick to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.

- C. Waterproofing. Waterproofing shall be factory applied to all exterior surfaces of vaults and risers. This includes the bottom of the vault to be coated as an exterior surface. Apply two coats at a rate of 65 square feet per gallon per coat. Prior to backfilling, field apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

3.5 CUTTING AND PATCHING

- A. Core Drilling: The installer shall be responsible for all core drilling as required for work under this section, but in no case shall the installer cut into or weld onto any structural element of the project without the written approval of the A&E. Any post tension slabs or slabs with embedded electrical raceways shall be X-rayed prior to coring by the installer.
- B. Cutting and Patching: All cutting, rough patching and finish patching shall be provided as specified in the contract documents. All cutting and patching shall be performed in a neat and workmanlike manner.
- C. Openings and Sleeves: Locate all openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.
- D. Roof Penetration: All roof penetrations for raceways part of technology systems shall be approved by A&E prior to executing this work. All roof penetrations shall be as accepted by the roof manufacturer.

3.6 IDENTIFICATION OF BOXES

- A. Tags: During installation of pull strings all pull strings shall be marked with waterproof vinyl tags indicating where the opposite end may be found.

3.7 BLANK PLATES

- A. Plates: Unless otherwise noted all unused outlet boxes shall receive blank plates matching the finish of plates for electrical devices in the same room.

3.8 RACEWAY INSTALLATION

- A. SUPPORT. All raceways shall be run in a neat and workmanlike manner and shall be properly supported and in accordance with the latest edition of the NEC code and BICSI guidelines. Supporting conduit and boxes with wire is not acceptable. Exposed raceways where allowed, shall be supported with clamp fasteners with toggle bolt on hollow walls, and with no lead expansion shields on masonry. All conduits shall be securely fastened in place with at least one support per eight foot section. Support within one foot of changes in direction. All required hangers, supports and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and

cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

- B. **HANGER INSTALLATION.** Where two (2) or more conduits one (1) inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.
- C. **NON-CONTINUOUS CABLE SUPPORTS INSTALLATION.** When j-hooks are allowed in the project by this specification (See USE OF CONDUIT FOR DIFFERENT SYSTEMS) non-continuous cable supports (j-hooks) shall be installed only as recommended by manufacturer not exceeding the load ratings of the devices. Install non-continuous cable supports in spans no longer than 4'. Whenever there are changes in elevation additional supports shall be required to avoid having stress on cable or sharp bends.
- D. **PENETRATIONS IN FIRE RATED PARTITIONS.** Installation of electrical boxes or equipment backboxes in fire rated walls and smoke barriers shall follow the following requirements:
 - 1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls as long as all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.
 - 2. As a summary, some of the requirements indicated by the codes listed above are:
 - a. Boxes shall be metallic or listed for that purpose
 - b. The area of the boxes shall not exceed 16 square inches, provided the aggregate area of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
 - c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
 - d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.
 - 3. Electrical boxes or technology systems backboxes shall not be installed in a 3 or 4 hour fire rated walls.
- E. **ROUTING:** Conduits shall be run parallel to building walls wherever possible, exposed or concealed as specified, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.
- F. **PROTECTION DURING CONSTRUCTION.** All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in and covers are in place. No conductors shall be pulled into raceways until the raceway system is clean and complete.
- G. **PROTECTIVE BUSHINGS:** All un-terminated conduits shall have an insulated protective bushing to avoid cable damage at the edge of the conduit.

- H. AVOIDING EMI: To avoid EMI for Telecommunications cabling and/or conduit containing cabling, all raceways shall provide clearances of at least four (4) feet (1.2 meters) from motors or transformers; one (1) foot (0.3 meter) from conduit and cables used for electrical-power distribution; and five (5) inches (12 centimeters) from fluorescent lighting. Raceways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The Installer shall not place any raceway alongside power lines
- I. COORDINATION. All raceways shall be kept clear of mechanical equipment and plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- J. MASONARY INSTALLATION. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- K. USE OF CONDUIT IN DIFFERENT AREAS. When low voltage cables (any technology system) have to be run above ground in a space with no type of accessible ceiling (interior or exterior), all cable runs shall be in conduit completely, continuing the raceways all the way to the nearest accessible ceiling (in the direction of the telecom closet) or grouping the raceways into a single larger diameter conduit with the same or larger cross sectional area than the sum of all the conduits coming into it. The use of j-hooks to support low voltage cables in areas with no ceiling or inaccessible ceiling (e.g. hard ceilings) shall not be allowed. This type of condition is usually not indicated in the drawings because design drawings don't show conduits smaller than 2", nevertheless it shall be provided as indicated herein.
- L. USE OF CONDUIT FOR DIFFERENT SYSTEMS: The following paragraphs indicate the design intent for raceways system for all technology systems.
 - 1. For all systems under division 27: Conduit stub up from the outlet to the nearest accessible ceiling, non-continuous support system to the nearest cable tray system [to the telecommunications room] [Conduit stub up from the outlet to the nearest cable tray or telecommunications room] [Conduit stub up from the outlet to the nearest telecommunications room]
 - 2. For all systems under Division 28 with the exception of Fire Alarm and Security Voice Communication system: Conduit stub up from the outlet to the nearest accessible ceiling, non-continuous support system to the nearest cable tray [to the telecommunications room] [Conduit stub up from the outlet to the nearest cable tray or telecommunications room] [Conduit stub up from the outlet to the nearest telecommunications room].
 - 3. Non-continuous support systems (J-hooks) are [not] allowed in this project as a horizontal support system for cables above ceilings. J-hooks shall not replace the cable tray system shown in the drawings.

3.9 CABLE TRAY INSTALLATION

- A. Inspection: Examine area for clearances, to allow proper installation of the tray according to the routing indicated on the drawings. Check existing building steel and other supporting structures to establish the type of tray hangers to be used and at the proper spans.
- B. Installation Criteria: Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply

with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines

- C. Support: Cable tray support shall be by means of welded angle brackets to structural components, brackets shall be as manufactured by the Cable tray manufacturer. Complete straight section of cable tray shall have at least 1 support at a $\frac{1}{4}$ of the length of the section. Additional supports are required at tray ends, offsets, bends and changes of elevation.
- D. Grounding: All conduits terminating within 12 inches of a cable tray shall be bonded with a grounded in accordance with the National Electric Code.
- E. Coordination: Wherever possible, install horizontal cable trays above water and steam piping. Coordinate installation of tray with other trades for clearances, to avoid conflicts. A minimum of 300 mm (12 in) access headroom shall be provided and maintained above the cable tray system or cable runway. A minimum of 150 mm (6 in) access headroom shall be provided and maintained at both sides (one side if tray is supported at the wall. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, structural elements) do not restrict access. The cable tray must be installed with at least 75mm (3 in) of clear vertical space above the ceiling tiles and support channels (T-bars) to ensure accessibility. When crossing other building components with the cable tray or runway the above specified clearances shall be maintained.

3.10 RUNWAY CABLE TRAY OR CABLE TRAY SYSTEM INSTALLATION INSIDE T.R.

- A. GENERAL. Runway cable tray systems or cable tray systems being installed inside telecom rooms shall be installed following manufacturer's recommendations for installation and all the following requirements indicated in this specification section.
- B. SUPPORT LOCATIONS. Supports shall be provided as recommended by the manufacturer, but as a minimum supports shall be located as follows:
 - 1. Before each 90 deg turn.
 - 2. No continuous section shall have more than 3ft of span without a support.
 - 3. At each 2-post rack or 4-post rack
 - 4. At each change in elevation
- C. SUPPORT TYPE. When the runway/cable tray is to be installed against the wall, the only support type to be used is a wall bracket supporting from the bottom of the tray. For sections of runway/cable tray to be installed over racks, the preferred support system is to the racks themselves. Trapeze style support brackets shall only be used when no other method of support is possible. **Center hung support systems shall never be used.**
- D. VERTICAL SECTIONS. Runway/cable tray system shall be installed continuously vertically in all telecommunications rooms in the project from sleeves coming from the ground (or floor below) to the sleeves going to the floor above, whether or not indicated in the drawings. The runway/cable tray installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. If the sleeves from the floor below to the floor above don't line up in a straight line, two vertical sections are accepted, one to the horizontal runway cable tray and one from the horizontal runway cable tray to the sleeves above. Runway/cable trays installed vertically shall have supports to the floor, wall and slab above.

- E. VERTICAL SECTIONS TO CONDUITS. Runway/cable tray shall be installed continuously vertically in all telecom rooms in the project when conduits larger than 2" terminate in the telecom room at the height higher than 4' from the highest vertical runway/cable tray installed above the racks. The runway/cable tray installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. The length of these sections of runway shall be the complete length from the vertical runway/cable tray to the conduits stubbing in the room. The idea for these runway/cable tray sections is to provide support for the cables coming out of the conduit to the vertical runways/cable trays. Runways/cable tray installed vertically shall have a standoff of no less than 1" from the wall to allow for proper lacing of the cables.
- F. CABLE DROP OUT. At each rack or cabinet that has runway/cable tray system running on top of it, a cable dropout shall be installed to protect the bend radii of the cable. This dropout accessory shall have a bend radius of no less than 4".
- G. BONDING. Any two continuous sections of runway/cable tray system shall be bonded together with a #1 bonding jumper (600A) 15" long. All bonding jumpers shall be made of steel with yellow, zinc-dichromate finish. All fasteners shall be made of steel with zinc-plated finish. See specification section 270526 for more details.
- H. PROTECTIVE END CAPS. All end sections of runway cable tray sections shall be protected with plastic protective end caps.

3.11 INSTALLATION OF INNERDUCT

- A. PROTECTION. Protect products from the effects of moisture, UV exposure, corrosion and physical damage during construction.
- B. SUPPORT. When inner duct is laid on a cable tray, it shall be strapped to cable tray with nylon ty-wraps at periodic intervals of no less than 4 ft.
- C. COLOR CODING. When multiple inner duct are in a single conduit, and innerduct are of the same size, they shall be different colors for identification or have different color electrical taped wrapped on the ends to identify them at the end of each conduit.
- D. USE OF INNERDUCT. Any continuous conduit installed below grade or above grade with a size of 3 inches or larger shall have innerducts inside, along the complete conduit run. In particular for 4" conduits, a minimum of three (3) innerducts shall be installed inside each conduit, regardless if cables are being run as part of this project or not. One of those innerducts shall be a 1-1/2", the other two innerducts shall be 1" innerducts.

3.12 USE OF FIRE STOP SYSTEMS

- A. CABLE TRAYS. Cable trays or tubular runways shall not be allowed to pass continuously through a fire rated partition or smoke barrier. The following guidelines shall be followed to seal those openings:
 - 1. Use only UL listed methods per the wall rating.
 - 2. Pillow type or brick type systems are not allowed.

3. For cable trays 12" in width or less, use only 4" through wall fitting fire stop systems. The quantity of systems shall be dependent on the cross sectional area of the cable tray system installed. The total cross sectional area of the fittings installed shall match the cross sectional area of the cable tray system installed. As an example, a 12" wide cable tray, 4" high shall have four (4) through wall fitting fire stop systems regardless of how many cables are being run on the cable tray system.
 4. For cable trays wider than 12", use a combination of 4" EMT sleeves with fire caulk based systems and through wall fittings fire stop system. The total cross sectional area of the sleeves/fittings installed shall match the cross sectional area of the cable tray system. To determine the quantity of sleeves and fittings for each case, the following method shall be used. All cables installed as part of this contract can be run through 4" sleeves with fire caulking and remaining sleeves, but no less than 1/2 of all sleeves required shall be through wall fitting fire stop systems. So, as an example an 18" wide, 4" high cable tray, requires a total of 6 4" sleeves. Out of those six, there shall be no less than three 4" through wall fitting fire stop systems with no cables installed inside and no more than three 4" sleeves with fire caulking with all cables installed as part of this contract, regardless of how many cables are being run on the cable tray.
- B. SMALL CONDUIT SLEEVES. When J-hooks are allowed in the project and small cable bundles are required to go through a rated partition, it is acceptable to use fire caulk. A small bundle of cables is defined as a bundle than can fit on a sleeve that is 1.5" in size or less. For larger bundles, requiring 2" sleeves or larger, use only through wall fitting fire stop systems.
- C. CONTINUOUS CONDUITS RUNS. Continuous horizontal conduit runs or conduit entering a rated telecom room shall be fire stop with caulk based fire stop systems, regardless of the size of the conduit.
- D. ELECTRICAL BOXES. Installation of electrical boxes or equipment backboxes in fire rated walls and smoke barriers shall follow the following requirements:
1. Electrical boxes and or technology system backboxes can be installed in 1 or 2 hour rated walls as long as all requirements indicated in the proper Building Code, National Electrical Code and nationally recognized testing laboratories are met for this type of installation.
 2. As a summary, some of the requirements indicated by the codes listed above are:
 - a. Boxes shall be metallic or listed for that purpose
 - b. The area of the boxes shall not exceed 16 square inches, provided the aggregate area of the openings through the membrane does not exceed 100 square inches in any 100 square feet of wall area.
 - c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch.
 - d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used.
 3. Electrical boxes or technology systems backboxes shall not be installed in a 3 or 4 hour fire rated rated walls.
- E. VERTICAL SLEEVES. Fire stop system shall be used for all 4" vertical sleeves used inside telecom rooms to run from one floor to the next. Half the sleeves indicated in the design drawings shall be protected with caulk based fire stop systems and the other half with through floor fittings fire stop systems.

3.13 AS BUILT DOCUMENTS AND CLOSE OUT INFORMATION

- A. See specification section 270010 for as built documents and close out information these requirements.

END OF SECTION 270528

271000 - STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. General: Telecommunications Drawings apply to work of this section. The overall and detailed Structured Cabling System (SCS) design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- B. General: Furnish, install, test and certify complete with all accessories an ANSI/TIA 568D SCS with a minimum 25 year performance warranty for the entire system from the manufacturers and a minimum of 3 years warranty for materials and labor from the SCS installer for all components not covered under the manufacturer's 25 year warranty. The goal of the project is to provide an enhanced SCS that shall serve as a vehicle for the transport of voice telephony, data, audio, video, security and low voltage devices for building controls and management, throughout the building and from building to building from designated demarcation points to outlets located at various desk, workstation and other locations as indicated in the contract drawings.
- C. Coordination with other trades: It is the responsibility of the installer of the SCS to verify and advise the installer of the raceway infrastructure (conduit, boxes, cable tray, in ground boxes, etc.) for this system on raceway routing to minimize the wiring distances to the telecommunication room. When J-hooks are acceptable for the use in structured cabling system, all J-hooks and supports for these devices shall be in the scope of work of the SCS installer.
- D. All patching and cross connect to owner provided equipment shall be included under the scope of work of this project.
- E. During the execution of the work, all required relocation, demolition, temporary connections, rerouting, etc., of existing cabling, equipment and systems in the existing building areas where the work is required, shall be performed by the SCS installer, as indicated on the drawings, or as required by job conditions and as determined by the Architect in the field, to facilitate the installation of the new systems. The Owner shall require continuous operation of the existing systems, while demolition, relocation work or new tie-ins are performed.
- F. WAP installation. The scope of work includes the installation of the Wireless Access Points (WAPs) provided by the owner. The scope includes the labor and installation materials (supports, anchors, etc.) to properly fasten the WAPs to the structure.

1.2 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section

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- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section:

SECTION	TITLE
270010	TECHNOLOGY GENERAL PROVISIONS
270528	RACEWAYS FOR TECHNOLOGY
270526	GROUNDING & BONDING FOR TELECOMMUNICATIONS SYSTEMS

- C. Owner standards: Comply with the document “Requirements for all Communication Cabling at Clients name” prepared by the Clients applicable office.
- D. Standards: All work related to the SCS shall be in compliance with the following industry codes and standards latest edition:
1. ANSI/TIA-568.0-D “Generic Telecommunications Cabling for Customer Premises” with addendums and errata.
 2. ANSI/TIA-568.1-D, “Commercial Building Telecommunications Cabling Standard” with addendums and errata.
 3. ANSI/TIA-568.2 - D, “Balanced Twisted- Pair Cabling Components Standard” with addendums and errata.
 4. ANSI/TIA-568.3-D, “Optical Fiber Cabling Component Standard” with addendums and errata.
 5. ANSI/TIA-569-D, “Telecommunications Pathways and Spaces” with addendums and errata.
 6. ANSI/TIA-606-C, “Administration Standard for Telecommunications Infrastructure” with addendum and errata.
 7. ANSI/TIA-607-D, “Generic Telecommunications Bonding and Grounding (earthing) for Customer Premises” with addendum and errata.
 8. ANSI/NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
 9. ANSI/TIA 758-B, “ Customer-Owned Outside Plant Telecommunications Infrastructure Standard” with addendum and errata
 10. ANSI/TIA 862-B, “Structured Cabling Infrastructure Standard for Intelligent Building Systems” with addendum and errata.
 11. ANSI/TIA-1152-A, “Requirements for Field Test Instruments and Measurement for Balanced Twisted Pair Cabling” with addendum and errata.
 12. ANSI/TIA-526-7-A, “Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant”.
 13. ANSI/TIA-526-14-C, “Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”.
 14. TIA-598-D, Optical Fiber Cable color coding.
 15. IEC/TR3 61000-5-2 - Ed. 1.0 and amendments. “Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling”
 16. ANSI/TIA-942-B , “Telecommunications Infrastructure Standard for Data Centers” with addendum and errata
 17. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 18. ANSI/NFPA 70 “National Electrical Code”, CSA C22.1.
 19. BICSI Telecommunications Distribution Methods Manual (TDMM)
 20. BICSI Telecommunications Cabling Installation Manual (TCIM)
 21. BICSI Customer Owned Outside Plant Manual (COOPM)
 22. Local County/City Codes, Ordinances and Regulations.
 23. Underwriters Laboratories (UL)
 24. FCC -Federal Communications Commission

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25. ADA Requirements
26. Occupational Safety and Health Regulations (OSHA)
27. National Fire Protection Association (NFPA)
28. ANSI/TIA-1179, Healthcare Facility Telecommunications Infrastructure Standards
29. Florida Statutes and Administrative Rules
30. Manufacturers Product Cabling Catalogs
31. Manufacturers Training Manuals (Design and Installation).

- E. General: Installation practices for SCS as describe herein take precedence over any other section in the construction documents set.

1.3 STRUCTURED CABLING SYSTEM INSTALLER QUALIFICATIONS

- A. General: The installer selected for the project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.
- B. General: The installer directly responsible for this work shall be a Structured Cabling System (SCS) Installer who is, and who has been, regularly engaged in the providing and installation of commercial and industrial telecommunications wiring systems of this type and size for at least the immediate past five years. Any other company working for the SCS installer of this system shall have the same training and certification as the SCS installer.
- C. Certification: The SCS installer's Project Manager shall possess a current and in Good Standings BICSI Registered Communications Distribution Designer (RCDD®) certificate. All shop drawings submitted by the SCS Installer shall bear the RCDD's stamp.
- D. The SCS Installer shall have a (BICSI) RCDD on Staff. Third party RCDD's shall not be acceptable.
- E. The Installer team leader assigned for the project shall be BICSI registered Level II installer or proven and qualified equal.
- F. Experience: The SCS Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The SCS Installer shall own and maintain tools and equipment necessary for successful installation and testing of SCS and have personnel who are adequately trained in the use of such tools and equipment. The Owner or engineer may elect to request submittal of additional financial, operational and administrative information of the SCS installer to demonstrate the required experience.
- G. The SCS Installer shall possess a State of Florida Low Voltage License.
- H. The SCS Installer shall maintain a permanent office within 150 miles of the project site.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. SCS Installer shall follow all requirements for materials alternates and substitutions indicated in specification section 270010.

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- B. Substitutions are only allowed for the SCS when the substitutions do not change the warranty of the SCS system as indicated in this specification section

1.5 SHOP DRAWINGS AND SUBMITTALS.

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. Proposal Submittals: The SCS Installer shall submit the following information with the proposal to execute the work:
 - 1. A list of five (5) recently completed projects of similar type and size with contact names and telephone numbers for each.
 - 2. A list of test equipment proposed for use in verifying the integrity of the installed SCS. Test equipment list shall include manufacturer part number, serial numbers and a copy of the last calibration report done by the manufacturer of the equipment of the unit, indicating the date when the calibration was done. Calibrations shall not be older than one year. Test equipment includes, cable certifiers, OTDRs, fiber splicers, etc.
 - 3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project, including RCDD license number.
 - 4. Similar documentation for any company working for the SCS Installers who will assist in the performance of this work.
 - 5. A copy of a current and valid Low voltage License for the State of Florida.
 - 6. Location of office from which installation and warranty work will be performed.
- C. Construction submittals: Once all proposal submittals have been received and approved by the Architect and Engineer (A&E) of the project, the SCS Installer shall provide all construction submittals. Construction submittals are composed of the following items.
 - 1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the cut sheets for the specific product being provided with an identifying mark, arrow, or highlighting.
 - 2. Faceplate color selection.
 - 3. Detail explanation of the labeling scheme to be used for all components of the system. This explanation shall include examples of all types of labels to be used, like labels for cables, patch panels, outlet jacks, etc.
 - 4. Autocad® or Revit drawings in sheets matching the size of the design documents with the following information:
 - a. Floor plans with all outlets in the project. All outlets shall have the label to be used during identification and tagging process described in this specification section.
 - b. Enlarged telecommunication rooms with all equipment components and rack layouts for each room. All racks shall have the label to be used during identification and tagging process described in this specification section.
 - c. Drawings indicating rack elevations for all cabinets or racks in the project, identifying the precise quantity of patch panels, fiber distribution centers and wire managers and accurate RU heights based on equipment selection. All equipment shall have the label to be used during the identification and tagging process described in this specification section.
 - d. A spreadsheet indicating all patch cords (fiber and copper) to be provided in the project. The spreadsheet shall indicate the quantity, color of the jacket, cable type, length and connector termination on each side.

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- D. Construction submittals received before proposal submittals are received or approved will be rejected.

1.6 ABBREVIATIONS

A. General: The following abbreviations are used in this specification section:

1. A&E - Architect and Engineer. The Architect is the legal entity that holds a contract for the design the project. The Engineer is the consulting engineer firm or engineer of record for the project who prepared this specification.
2. APC - Angle physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
3. Array connector - a multi-strand fiber connector user for high density applications, such as the MPO connector
4. BICSI - Building Industry Consultant Services International
5. CCTV - Close circuit television system (surveillance video system)
6. FCC - Federal Communications Commission.
7. FTP - Foiled Twisted pair. One foiled screen around each cable pair.
8. IDC - Insulation Displacement Connector
9. NEC - National Electrical Code.®
10. NEMA - National Electrical Manufacturers Association.
11. OM1 - ISO 11801 designation for multimode 62.5/125µm glass fiber optics.
12. OM2 - ISO 11801 designation for multimode 50/125µm glass fiber optics.
13. OM3 - ISO 11801 designation for multimode laser optimized 50/125µm glass fiber optics.
14. OM4 - TIA designation for multimode laser optimized 50/125µm glass fiber optics in compliance with TIA-492-AAAD.
15. OS1 - ISO 11801 designation for single mode 9/125µm glass fiber optics.
16. OS2 - ISO 11801 designation for single mode 9/125µm glass fiber optic with performance criteria identical to ITU-T G652.
17. OTDR - Optical Time Domain Reflectometer.
18. RU - Rack units. Height dimension for rack mounted equipment. 1 RU equivalent to 1.75”.
19. SCS - Structured Cabling System
20. ScTP - Screened twisted pair. One foiled screen around all cable pairs
21. TIA - Telecommunications Industry Association.
22. TR - Telecommunications Room.
23. UPC - Ultra physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
24. UTP - Unshielded twisted Pair
25. UV - Ultra violet
26. VAC - Volts alternating current.

PART 2 - PRODUCTS

2.1 MODULAR SCS JACKS

- A. Structured cabling system outlets indicated in design drawings are composed of modular SCS jacks, mounted in a faceplate on an electrical box. Modular SCS jacks shall be 8-pin modules (RJ-45) that meet or exceed the following electrical and mechanical specifications:
1. Electrical Specifications:
 - a. Insulation resistance: 500 M Ω minimum.
 - b. Dielectric withstand voltage 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
 - c. Contact resistance: 20 M Ω maximum.
 - d. Current rating: 1.5 A at 68 ° F (20 ° C) per IEC publication 512-3, Test 5b
 - e. ISO 9001 Certified Manufacturer
 - f. UL verified for ANSI/TIA electrical performance
 - g. Comply with FCC Part 68
 - h. Cable termination: IDC type universal T568A or T568B.
 2. Mechanical Performance:
 - a. Plug Insertion Life: 750 insertions
 - b. Contact Force: 3.5 oz (99.2 g) minimum using FCC-Approved modular plug.
 - c. Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
 - d. Temperature Range: -40° to 150°F (-40 ° to 66 ° C)
- B. Design selection: modular SCS jacks shall be selected according to the following criteria:
1. Performance requirement: CAT6, CAT6A
 2. Style: Rear loading [front loading with adapter panel] [front loading with panel formed with jack]
 3. Mounting orientation: straight mounting angled (45°) mounting
 4. Color: To match faceplate [specific color]
 5. Dust cover required: No Yes
 6. Shielding: use shielded modular jacks only with ScTP cable.
- C. Approved manufacturer: Ortronics, Panduit, Siemon, CommScope, Belden, Leviton or Hubbell.

2.2 FIELD TERMINATABLE 8 POSITION MODULAR PLUG

- A. When indicated in the design drawings to use Direct Attach connection for any field devices, field terminatable 8 positions modular plugs shall be used. This devices shall be 8-pin modules (RJ-45) plugs that meet or exceed the following electrical and mechanical specifications:
1. General Specifications:
 - a. Shall include an IDC type of termination for the cable. Crimp type terminations not acceptable.
 - b. Shall support cable gauges from 22 to 26 AWG
 - c. Shall include a rubber boot
 2. Electrical Specifications:
 - a. ISO 9001 Certified Manufacturer
 - b. UL verified for ANSI/TIA electrical performance
 - c. Comply with FCC Part 68

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d. Cable termination: IDC type universal T568A or T568B.

- B. Design selection: modular SCS jacks shall be selected according to the following criteria:
1. Performance requirement: Match performance of Modular SCS jacks
- C. Approved manufacturer: Match selection for modular SCS jacks.

2.3 OTHER MODULAR JACKS

- A. Whenever indicated in the design drawings SCS outlets could have terminations for other media types like fiber optic cables, coaxial cables or audio cables. Whenever those type of media are identified in the drawings, the following specifications shall be met for modular jacks mounted in SCS outlets:
1. Style, mounting orientation and color: match design selection for modular SCS jacks.
 2. Broadband distribution system connector: Use modular jack with F connector bulkhead rated at 75Ω.
 3. Fiber optic connectors: use modular jack with adapter plate for SC/ST/LC/MTRJ simplex/duplex connector.
 4. For line level audio signals: use modular jack with RCA connector bulkhead. Use different color coded insulators for different audio channels.
- B. Approved manufacturer: Match selection for modular SCS jacks.

2.4 FACEPLATES

- A. Faceplates shall be used for all flush mounted telecommunication outlets to house modular jacks. Faceplates shall have the following specifications:
1. Construction material: High impact thermo Plastic Stainless Steel.
 2. Size: use single gang faceplates only unless specifically noted in the design drawings.
 3. Capacity of modular jacks per faceplate: faceplate shall be selected as to accommodate the amount of cables in each telecommunication outlet. No more than one unused opening shall be present on each faceplate.
 4. Color: submit color to A&E for approval.
 5. Labels: faceplate shall have two (2) recesses for labels, top and bottom, and shall have transparent label snap-on covers.
 6. Faceplate style: Direct modular plug rear loading style, [106-type with 106-type frame for modular plugs], [decora type with mounting frame], [front loading plug style].
- B. All faceplates shall have a tamper resistant cover to access the modular jacks
- C. Approved manufacturer: Match selection for modular SCS jacks.

2.5 FACEPLATES WITH SUPPORT STUDS

- A. Telecommunication outlets indicated in the design drawings as to be wall mounted telephone outlets shall be composed of one modular SCS jack and one faceplate with support studs mounted on an electric box. Faceplates with support studs shall have the following specifications:

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1. Construction material: Stainless Steel.
2. Size: use single gang faceplate with two support studs.
3. Capacity of modular jacks per faceplate: One.
4. Faceplate style: Direct modular plug rear loading style.

B. Approved manufacturer: Match selection for modular SCS jacks.

2.6 SURFACE MOUNTED BOXES

- A. Telecommunication outlets indicated in the design drawings as to be surface mounted outlets shall be composed of modular jacks mounted in a surface mounted box inside an electrical enclosure. Surface mounted boxes shall have the following specifications:
1. Construction material: High impact thermo Plastic.
 2. Capacity of modular jacks per surface mounted box: size of surface mounted box shall be selected as to accommodate the amount of cables in the surface mounted telecommunication outlet. No more than one unused opening shall be present on each box.
 3. Color: White.
 4. Labels: surface mounted boxes shall have at least one (1) recess for labels, and shall have transparent label snap-on covers

B. Approved manufacturer: Match selection for modular SCS jacks.

2.7 MOUNTING FRAMES

- A. All telecommunication outlets shall be properly mounted in the electrical raceway system provided for the outlet. The SCS installer shall select the proper mounting frame and/or bezel to mount the modular plugs in the raceway system. Raceway systems include furniture systems, floor boxes, poke-thrus, power poles, surface raceways system, etc.
- B. Whenever design drawings indicate a telecommunication outlet to be mounted in a furniture system the SCS Installer shall select the proper mounting frame to hold the modular jacks in the furniture system selected by the owner. Color of the mounting frames shall match the color of the furniture system.
- C. If owner provided furniture system does not have a raceway system for telecommunication, and design drawings indicate outlet to be mounted in the furniture system, SCS installer shall provide a plastic surface mounted box that allows the mounting of the modular plugs in a standard telecommunication faceplate.
- D. SCS installer shall provide all mounting frames and bezels to mount modular jacks inside floor boxes or poke-thrus.
- E. All un-used ports in mounting frames shall be covered with blank inserts.
- F. Approved manufacturer: Match selection for modular SCS jacks.

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2.8 HORIZONTAL 4-PAIR CABLE

- A. General: Horizontal 4-pair cables shall be extended between the telecommunications outlet location and its associated equipment inside the TR. The cable shall consist of 4 pair cable solid copper conductors, certified to the specified performance standard. All horizontal 4-pair cables shall be terminated in modular jacks and patch panels with IDC type connectors and shall have the following specifications:
1. Cable Gauge: minimum 23 AWG
 2. Performance standard: ANSI/TIA CAT6A
 3. Cable type: UTP
 4. Performance characterized to: 500 MHz
 5. Time delay skew: Maximum 45 ns/100m
 6. Input impedance (1-100MHz): 100Ω
 7. Cable shall be UL certified for Limited Power (LP) Applications
 8. Cable diameter: ≤ 0.295 inch
- B. Cable jacket colors for 4-pair horizontal cables shall be selected according to the following criteria:
1. Voice or data cables: Blue
 2. Wireless access points: Green
 3. Surveillance cameras: Yellow
- C. Performance verification: All performance of horizontal 4-pair cable shall be verified by a Nationally Recognized Testing Laboratory (NRTL) for ANSI/TIA electrical performance and comply with FCC Part 68.
- D. Jacket: Cable jacket for inside premise cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.
- E. OSP Jackets: All horizontal 4-pair cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable for this application.
- F. Jacket marking: All horizontal 4-pair cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.
- G. Approved manufacturer: Superior Essex, Belden, Panduit, Siemon, CommScope General Cable, or Berk-Tek.

2.9 PATCH PANELS FOR HORIZONTAL CABLING

- A. All 4-pair horizontal cables shall be terminated in rack mounted path panel located in the telecommunication rooms rack. These patch panels shall have the following specifications.
1. Connector type: 8-position modular plug (RJ-45)
 2. Cable termination: IDC type universal T568A or T568B.
 3. Performance requirement: CAT6, CAT6A
 4. Maximum connectors per path panel allowed: 48 96

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5. Patch panel type: factory preloaded panels rear loaded panels (use modular SCS jacks for all inserts)
6. Patch panel shape: straight (flat) [angled] [curved]
7. Permanent marking: All connectors shall be labeled in sequential numbers
8. Field labels: patch panels shall have a space for field labels covered with transparent protectors.
9. Shielding: use shielded patch panels only with ScTP cable.

- B. Approved manufacturers. Match selection for modular SCS jacks

2.10 HORIZONTAL WIRE MANAGERS

- A. Horizontal wire managers shall be mounted in racks to route cables from patch panels to vertical wire managers and to equipment. Horizontal wire managers shall have the following specification:
1. Style: Finger duct style with hinged cover multiple rings finger duct style with removable cover
 2. Sides: front of rack front and back of rack
 3. Minimum height: two RU, four RU

- B. Approved manufacturers. Match selection for modular SCS jacks

2.11 CROSS OVER WIRE MANAGERS

- A. Cross over wire managers shall be used to route patch cables from the right vertical wire manager to the left vertical wire manager or between racks. Cross over wire managers shall have the following specification:
1. Style: six port finger spacing with a cover
 2. Sides: front of rack
 3. Minimum height: Four RU

- B. Approved manufacturers. Match selection for modular SCS jacks

2.12 FOUR (4) PAIR PATCH CORDS

- A. Four (4) pair patch cords are required at the work area side and at the patch panel side to complete the connectivity path to the equipment. All 4-pair patch cords shall be factory tested and shall have molded boots to the cable jacket. Field made patch cords are not acceptable. Four pair patch cords shall have the following specifications:
1. Connectors: 8-pin modular plugs at both ends
 2. Conductors: 4-pair stranded conductors.
 3. Wire gauge: 23AWG for patch cords in the field site and 28 AWG for patch cords in the telecom room side
 4. Wiring map: See section 3 of this specification
 5. Performance requirement: To match horizontal 4-pair cable performance
 6. Cable type: UTP ScTP FTP [match horizontal cable selection]

- B. Approved manufacturers. Match selection for modular SCS jacks

2.13 SINGLE STRAND FIBER OPTICS CONNECTORS

- A. All fiber optic cables (horizontal or backbone cables) shall be terminated on fiber optic connectors at both ends of the cable with either single strand fiber optic connectors or array connectors. Single strand fiber optic connector shall be compliant with industry standard ANSI/TIA-568-C.3 and the applicable ANSI/TIA Fiber Optic Connector Intermateability Standard (FOCIS) document, ANSI/TIA 604 series. Single strand fiber optic connectors shall have the following specification:
1. Physical contact type: use UPC type connector for all application with the exception of applications of Broadband TV distribution systems or DAS systems. For those applications use APC type connectors.
 2. Connector type: SC LC or ST
 3. Security level: non-keyed connector keyed connector
 4. Pairing style: simplex duplex
 5. Acceptable connector attachment types:
 - a. Epoxy type connectors, field polished
 - b. Epoxyless (Crimp) type connector, field polished.
 - c. Splice on connectors. Fusion spliced connectors with factory polished finish.
 - d. Fusion spliced pig tail with factory polished connector. Mechanical splices for pig tails are not acceptable.
 6. Fiber type: SCS installer shall select the connector according to the fiber type where connector will be installed. As an example use OM1 connectors only in OM1 fiber optic cables.
 7. Fusion spliced pig tails. When using fusion spliced pig tails the SCS installer shall make sure the fiber type of the pig tail and the actual cable have the same optical characteristics, such as back scatter, core diameter, etc.
 8. Ferrule construction: use ceramic ferrule connectors only, plastic ferrules are not acceptable.
- B. All single strand fiber optic connectors shall include boots to protect the fiber optic cable. The SCS installer shall select the boot according to the fiber optic type selected. As an example use 900µm boots in 900µm coated fiber, use 250µm boots on 250µm coated fiber and use 2mm boots on 2mm jacketed fiber. All boots shall be color coded to identify the type of fiber connector used. Boots shall be beige for OM1 fiber, black for OM2, aqua for OM3 and OM4 or green.
- C. Single strand multimode fiber optic connectors shall have the following performance requirements:
1. The maximum insertion loss shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
 2. Connector reflectance shall be less than or equal to -26 dB when installed in accordance with the manufacturer's recommended procedure.
 3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
 4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90° angle, with a maximum 0.5dB increase in attenuation for both tests when tested in accordance with ANSI/TIA-455-6B.
- D. Single strand single mode fiber optic connectors shall have the following performance requirements:

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1. Maximum insertion loss shall be 0.75 dB per each mated connector pair when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
2. Connector reflectance shall be less than or equal to -40 dB (UPC) when installed in accordance with the manufacturer's recommended procedure.
3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90° angle, with a maximum 0.5 dB increase in attenuation for both tests when tested in accordance with ANSI/TIA-455-6B.
5. Connectors shall meet the following performance criteria:

Test	Procedure	Maximum Attenuation Change (dB)
Cable Retention	FOTP-6	0.2 dB
Durability	FOTP-21	0.2 dB
Impact	FOTP-2	0.2 dB
Thermal Shock	FOTP-3	0.2 dB
Humidity	FOTP-5	0.2 dB

- E. Approved manufacturers. Ortronics, Corning, Belden, Panduit, Siemon, Leviton, CommScope or 3M

2.14 FIBER OPTICS ARRAY CONNECTORS

- A. Fiber optics array connectors used in the project shall have the following specification:
1. Only factory terminated connectors shall be used.
 2. Connector shall be in compliance with intermateability standard TIA-604-5-C.
 3. Connector shall be factory tested to Telcordia GR-1435-CORE standard.
- B. Approved manufacturers. Match selection for single strand fiber optics connectors

2.15 FIBER OPTICS SPLICES

- A. When fiber splicing is required in the project because of the use of pigtails or field splicing, only fusion splicing will be acceptable. Mechanical splices shall not be used unless specifically indicated in the contract documents.
- B. All fiber splices shall be terminated with heat shrink sleeves and organized in splice trays. Splice trays sizes shall be selected to match the quantity of fiber strands in the cable bundles. Splice trays shall be organized in Fiber Optics Distribution Centers when inside a telecom room or in outdoor rated splice closures when done outdoors.
- C. Fusion splice equipment to be used in this project shall have the following specifications:
1. Alignment system: Automatic Core Detection system (ACD). V-groove splicers are not allowed.
 2. Typical splice loss for single mode fibers: 0.02 dB
 3. Splice loss result: Estimated (ACD) Measurement (LID)
 4. Unit shall have a fast heat shrink oven, maintenance free electrodes, built in cleaver and graphical user interface to display alignment condition.
 5. Cleaver blade type: diamond.

2.16 INSIDE PREMISE FIBER OPTICS HORIZONTAL CABLES

- A. Telecommunications outlets could have fiber optic terminations. Whenever design drawings indicate fiber optic terminations, inside premise fiber optic horizontal cables shall be used. The following are the specifications for fiber optic horizontal cables:
1. Strand Count: Two (2) strands as indicated in design drawings
 2. Fiber type: OM1 OM2 OM3 OM4 OS1/OS2 as indicated in design drawings
 3. Fiber coating: 900µm coating color coded
 4. Fiber protection: aramid yarn
 5. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
 6. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.
- B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated. Rating shall be printed in the cable jacket.
- C. OSP Jackets: All fiber optic horizontal cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable with this application.
- D. Approved manufacturers. Match selection for horizontal 4-pair cable

2.17 INSIDE PREMISE FIBER OPTICS BACKBONE CABLES

- A. Whenever design drawings indicate fiber optics backbone cables to be run inside premises, the following specification shall be followed for those cables:
1. Strand Count: As indicated in design drawings
 2. Fiber type: As indicated in design drawings
 3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable.
 4. Fiber protection: aramid yarn around all strands for cables under 24 strands, and aramid yarn and jacket around each subunit (6 or 12 strands) for cables above 24 strands.
 5. Interlock requirement: Interlock aluminum [dielectric] armor is required is not required
 6. Jacket type: Flame-retardant PVC jacket or materials with superior performance.
 7. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.
 8. Fiber termination: fibers shall be field terminated Fiber shall be factory terminated with Array connectors.
 9. Buffer type: tight buffer required loose buffer acceptable.
 10. Center strength member material: dielectric material
- B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.

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- C. Approved manufacturers: Match selection for horizontal 4-pair cable

2.18 OUTSIDE PLANT FIBER OPTICS BACKBONE CABLES

- A. Whenever design drawings indicate fiber optics backbone cables to be run between building or outside premises, the following specification shall be followed for those cables:
 - 1. Strand Count: As indicated in design drawings
 - 2. Fiber type: As indicated in design drawings
 - 3. Fiber coating: 250µm coating protected with break-out kits with color coded 900µm buffers at both ends of the cable when cables are terminated in conditioned spaces. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
 - 4. Rodent protection requirement: required not required
 - 5. Buffer type: Loose tube.
 - 6. Center strength member material: dielectric material
- B. Jacket: All outside plant fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
 - 1. ANSI/TIA-568-C
 - 2. Telcordia GR-20
 - 3. ANSI/ICEA S-87-640
- C. Approved manufacturers. Match selection for horizontal 4-pair cable.

2.19 INDOOR/OUTDOOR FIBER OPTICS BACKBONE CABLES

- A. Whenever design drawings indicate indoor/outdoor fiber optics backbone cables to be run between buildings or outside premises, the following specification shall be followed for those cables:
 - 1. Strand Count: As indicated in design drawings
 - 2. Fiber type: As indicated in design drawings
 - 3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
 - 4. Rodent protection requirement: required not required
 - 5. Buffer type: tight buffer required loose buffer acceptable.
 - 6. Center strength member material: dielectric material
- B. Jacket: All indoor/outdoor fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
 - 1. ANSI/TIA-568-C
 - 2. Telcordia GR-409
 - 3. ANSI/ICEA S-104-696

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- C. Jacket: Cable jackets for indoor/outdoor fiber optic cables shall also comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.
- D. Approved manufacturers. Match selection for horizontal 4-pair cable

2.20 FIBER OPTIC DISTRIBUTION CENTERS

- A. All fiber optic cables shall be terminated in fiber optic distribution centers. Inside premises horizontal fiber optic cables shall be terminated in one side (telecommunication room side) in a fiber optics distribution center (FODC). Backbone fiber optic distribution centers shall be terminated at both ends in a FODC. FODC are composed of an enclosure and snap on adapters. These are the specifications of the enclosures for the FODC:
 - 1. Mounting: Use rack mounted FODC enclosures in all rooms where racks are available or any type of rack rails. Use wall mounted FODC enclosures only when racks are not available like in outdoor enclosures, or other spaces different than telecom rooms.
 - 2. Size: SCS Installer shall size the FODC based on the amount of fiber strands to be terminated in the FODC.
 - 3. Front locking doors are required.
 - 4. Locking door shall be transparent doors and shall have labeling cards.
 - 5. Whenever fiber splices are indicated in the design drawings next to an FODC, enclosures shall be selected by the SCS installer as to have spaces to hold splice trays. FODCs under these conditions shall be able to hold the amount of splice trays required for the fiber count indicated in the drawings.
- B. These are the specifications of the snap on adapters for the FODC:
 - 1. Style: plate style cassette style for array connector
 - 2. Connector type: SC LC MTR-J ST MPO to match fiber types of fiber optic cables
 - 3. Maximum fiber strands allowed per adapter: 12 24
 - 4. Security level: non-keyed connector keyed connector
 - 5. Pairing style: simplex duplex
- C. Approved manufacturers. Match selection for fiber optic connectors

2.21 FIBER OPTICS PATCH CORDS

- A. Fiber optic patch cords shall be required for connections from active equipment to FODCs and/or to telecommunication outlets. Fiber optic patch cords shall be required at both ends of fiber optics backbone cables or horizontal fiber optic cables. Direct connection of backbone cables or horizontal fiber optic cables to active equipment shall not be allowed.
- B. Fiber optic patch cords shall be all factory tested. Field made fiber optic patch cords are not acceptable. The specifications of the fiber optic patch cords shall be:
 - 1. Strand Count: 2 strands
 - 2. Fiber type: Match fiber type of backbone cable or horizontal cable.
 - 3. Fiber connector in FODC or outlet side: match connector for each adapter

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4. Fiber connector in active equipment side: the SCS installer shall coordinate with supplier of equipment the type of connector required in this side.
5. Fiber protection: aramid yarn
6. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
7. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.

- C. Approved manufacturers. Match selection for fiber optic connectors

2.22 INSIDE PREMISE MULTIPAIR BACKBONE CABLES

- A. Whenever indicated in the drawings multipair backbone cables to be run inside premises and above grade shall have the following specification:
1. Pair count: as indicated in the design drawings
 2. Conductor: AWG 24 solid bare copper conductor
 3. Input impedance: 100 Ω
 4. Conductor insulation: color coded thermo plastic
 5. Performance requirement: UL verified to ANSI/TIA-568-C Category 3 5e backbone cable.
- B. Jacket: Cable jacket for inside premise multipair backbone cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.
- C. Jacket marking: All inside premise multipair backbone cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.
- D. Approved manufacturer: Belden, Superior Essex, General Cable, Berk-Tek or CommScope.

2.23 OUTSIDE PLANT MULTIPAIR BACKBONE CABLES

- A. Whenever indicated in the drawings outside plant multipair backbone cables to be run between buildings or inside premises but below grade shall have the following specification:
1. Pair count: as indicated in the design drawings
 2. Conductor: AWG 24 solid bare copper conductor
 3. Input impedance: 100 Ω
 4. Conductor insulation: Solid polyolefin; color coded in accordance with industry standards.
 5. Performance requirement: UL verified to ANSI/TIA-568-C Category 3 backbone cable.
 6. Shield: Corrugated, copolymer coated, 8 mil aluminum tape applied longitudinally with an overlap; flooded shield interfaces.
 7. Jacket: Black, polyethylene
- B. Jacket: All outside plant multipair backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant multipair backbone cables shall be tested and in compliance with following standards:

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1. ANSI/ICEA S-84-608-2007
2. RDUP 7 CFR 1755.390 (PE-39)
3. RoHS-compliant

C. Approved manufacturer: Match selection for inside plant multipair backbone cables.

2.24 TERMINATION OF MULTIPAIR BACKBONE CABLES

A. Backbone multipair backbone cables for inside premises or outside plant shall be terminated in termination blocks or patch panels. See design drawings for specific types on each case.

B. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in patch panels. Patch panels for this purpose shall have the following specifications:

1. Connector type: 8-position modular plug (RJ-45)
2. Connector wiring map: One pair per connector pins 4 and 5 (blue pair).
3. Cable termination type: IDC type connector 50-pin connector RJ-21
4. Performance requirement: CAT3
5. Maximum connectors per patch panel allowed: 96
6. Permanent marking: All connectors shall be labeled in sequential numbers
7. Field labels: patch panels shall have a space for field labels covered with transparent protectors.
8. Shielding: Unshielded.

C. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in rack mounted termination blocks. Termination blocks for this purpose shall have the following specifications:

1. Connector type: 110 style connector
2. Cable termination type: IDC type connector
3. Performance requirement: CAT3
4. Rack frame: standard 19" rack.
5. Pair counts: use 100 pair blocks for backbone cables under 100 pairs. Use 200 pair blocks in quantities as required for backbone cables with over 200 pairs.
6. Wire managers: All 200 pair termination blocks shall have a 2 RU wire manager built-in.
7. Clip types: Use 110C4 clips or 110C5 clips.
8. Field labels: termination blocks shall have a space for field labels covered with transparent protectors.
9. Mounting: termination block shall be mounted without legs in the rack plate.

D. Whenever indicated in the design drawings, multipair backbone cables shall be terminated in wall mounted termination blocks. Termination blocks for this purpose shall have the following specifications:

1. Connector type: 110 style connector or 66 Style
2. Cable termination type: IDC type connector
3. Performance requirement: CAT3
4. Pair counts: Use only 300 pair blocks in quantities as required for backbone cables.
5. Wire managers: All termination blocks shall have a wire manager installed at both sides of the blocks and between blocks.
6. Clip types: Use 110C4 clips or 110C5 clips for 110 style block [4] [6] clips per row 66 blocks

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7. Field labels: termination blocks shall have a space for field labels covered with transparent protectors.
 8. Mounting: termination block shall be mounted with legs on the wall.
- E. Approved manufacturers. Match selection for modular SCS jacks

2.25 SITE COPPER PROTECTORS

- A. General: When required by NEC or when indicated in the drawings copper circuits shall be provided with protection between each building with an entrance cable protector chassis. All building-to-building circuits shall be routed through this protector. Protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TR ground point.
- B. General: Primary protection units shall be composed of a cabinet that supports 5-pin protection modules and termination blocks. The cabinet for protection unit shall have the following specifications:
1. Capacity: 100 pairs
 2. Socket type: 5-pin modules
 3. Input mode: 110 style IDC connector.
 4. Output mode: 110 IDC
 5. Grounding lug capacity: AWG 6 to AWG 14
 6. Other: stand-off bracket required.
- C. The protector unit for digital lines shall have the following specifications:
1. Mounting type: 5-pin module.
 2. Protection type: Solid state MOV
 3. Pairs per unit: one
 4. Protection type: heat coil and sneak current protection
 5. DC Breakdown Voltage @ 2kV/sec: 60-90 V
 6. Surge Breakdown Voltage @100 V / μ sec: 220-300 V
 7. Insulation Resistance (PE-80): > 100 M Ω
 8. DC Holdover Current: 260 mA/52 V
 9. On-State Voltage @ 75 A: < 10 V
 10. Response Time: < 100 nsec
 11. Rated Impulse Discharge: 100 A
 12. Capacitance(VDC=50 V, f=1 kHz, V AC=1 Vrms): < 100pF
 13. Line Series Resistance: < 4 Ω
 14. Sneak Current Operation (heat coils): 540 mA <210 sec, 1 A <15 sec
 15. Listing: UL 497
- D. The protector unit for analog lines shall have the following specifications:
1. Mounting type: 5-pin module.
 2. Protection type: Solid state MOV
 3. Pairs per unit: one
 4. Protection type: heat coil and sneak current protection balanced
 5. DC Breakdown 240 V
- E. Approved Manufacturers for primary protectors: Commscope, Tii, Circa and Emerson

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- F. All primary protection block shall be used with a secondary protection block. The secondary protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TR ground point. Secondary protection shall have the following specifications:
1. Style: Mounted on a 66-type block.
 2. Protection type: solid state and fuse protection
 3. Pairs per unit: one
 4. Breakdown voltage: selected by SCS installer according to signals protected.
 5. Maximum number of protectors per block: 25
 6. Listing: UL 497A
- G. Approved Manufacturers for secondary protectors: Commscope, Emerson, Siemon

2.26 PATCH CORDS FOR MULTIPAIR BACKBONE CABLES

- A. Patch cords shall be used to connect horizontal wiring to termination blocks for multipair backbone cables. Depending on the type of termination for backbone cables, the patch cord shall be selected.
- B. When multipair backbone cables are terminated in patch panels, patch cords for these patch panels shall have the same specification as the 4-pair patch cord cables described above.
- C. When multipair backbone cables are terminated in wall mounted or rack mounted termination blocks, patch cords shall have a patch plug connector in one end and an 8-pin modular plug (RJ-45) in the other end. The SCS installer shall coordinate with the phone system installer and determine if one pair or two pairs are required for each phone. Patch cords shall have one or two pairs according to the equipment selection. Patch plugs shall only be one or 2 pairs accordingly. Patch plug selection shall match the manufacturer and family of products of the termination blocks.

2.27 EQUIPMENT CABINETS

- A. Whenever indicated in the design drawings equipment cabinets shall be provided as shown. Equipment cabinets shall be made of all welded steel frames and shall have a powder coat finish. Equipment cabinets shall have the following specifications:
1. Cabinet construction material: Welded and bolted steel frame.
 2. Footprint: As indicated in the design drawings.
 3. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
 4. Rack rails type: standards EIA/ECA 19" square holes with cage nut rail located in the front and back of cabinet. Rack rails shall be adjustable for depth and shall have RU marked and labeled.
 5. Rack screw type: cage nuts clipped to rack rails. Nuts and screws shall be provided for all slots in rack rails and shall be made of steel threaded as #10-32.
 6. Side panels (end of row cabinet sides): solid steel, removable and lockable side panels.
 7. Side panels (between adjacent cabinets): solid steel, removable panels with openings for passing cables, covered with plastic removable caps, rubber caps or brush openings. No less than Eight (8) openings in total area of the side of the cabinet. Each opening shall be no less than 34 sq inches.

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8. Top panel: solid steel with no less than four (4) brush protected openings for cables. Each opening shall be no less than 34 sq inches.
9. Bottom panel: solid steel with no less than two (2) brush protected openings for cables. Each opening shall be no less than 34 sq inches. For cabinets with top exhaust duct, a bottom air director shall be provided in the back side of the cabinets to force air up towards the exhaust duct.
10. Door hinge supports shall be provided at both sides of the racks and front and back to be able to reverse doors.
11. Grounding: Prepared location for ground lug at the top and bottom of the cabinet frame. Door shall include bonding jumper to cabinet.
12. Weight capacity: UL listed for 2500 lb
13. Finish: Epoxy-polyester hybrid powder coat paint on frame, rails, panels and metal accessories:
14. Finish color: White Black for all parts of the cabinet

B. Equipment cabinets shall be provided with the following accessories:

1. Front 78% perforated panel hinged door with key lock.
2. Rear 78% perforated panel solid split hinged doors with lock.
3. Locking system: locks for front and rear doors shall be two point latching locks and shall be keyed identically for front and rear lock. All locks for cabinets for each user ground shall be keyed alike but different between user groups.
4. Leveling feet and any accessories required to be able to bolt the cabinet to the floor with ½" screws or rods. Four (4) casters are required.
5. Vertical wire managers covering the full height of the rack rails. Two in the front. Vertical wire managers shall be selected as recommended by equipment cabinet manufacturer to avoid obstructions to rack rails or doors. Vertical wire managers shall have brush openings to run cables between front and back of cabinet and shall have all openings sealed to avoid air leakage between front and back.
6. Steel top exhaust duct, made of two separate sections to allow adjusting the height. Installer shall confirm final ceiling height in the room and order these ducts in a length as to provide adjustment for no less than 2" above and below of the final ceiling height. Top exhaust section shall have a rubber gasket to allow for good seal in ceiling imperfections.
7. Filler panels: For all racks with SCS installer provided equipment, all un-used rack spaces shall be covered with filler panels to avoid any air flow between front and back of cabinet. For all racks with owner provided equipment, the installer shall provide no less than 50% of all rack spaces in all racks with filler panels to prevent air flow between front and back of cabinet. All cabinets with no equipment installed at the end of the project shall have the front door wrapped with plastic wrap to prevent any air flow through the cabinet.
8. Air dam: The cabinet shall be provided with an air dam blocks airflow around the sides and top of the equipment mounting space, so cold air passes through equipment and hot air does not re-circulate around equipment. Any other additional type of seal required to prevent air flow from the front of the cabinet to the back shall be provided.
9. PDU bracket: PDU brackets shall be provided in each cabinet according to the number of vertical PDUs programmed to be installed in each cabinet. See drawings for quantities. These brackets shall be selected by the SCS installer as to match the support holes of the PDU selection for each cabinet.
10. All cabinets with equipment installed with substantial amount of cables terminating in the rear of the equipment, such as audio/visual systems and security systems shall be provided with enough cable lashing metal brackets to strap all cables to the frame for proper organization and support.

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11. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threaded holes 1032 mounted to the cabinet using nylon insulation washers
- C. Required equipment cabinet certifications: Complaint with EIA/ECA 310-E and UL 2416 listed
- D. Airflow re-director: The manufacturer of the equipment cabinet shall offer an air flow re-director kit for the type of cabinet selected for this project to allow for changing air flow direction of equipment designed for side to side ventilation. The SCS installer shall provide air flow re director kits for all cabinets in the plans with Core switches or network equipment.
- E. Field cuts or openings. Any cabinets with field cuts or perforations will be rejected and the SCS installer shall provide a new cabinet to remedy the condition.
- F. Approved manufacturer: Panduit, Ortronics, Eaton, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal.

2.28 QUAD POST RACKS

- A. Whenever indicated in the design drawings quad post racks shall be provided as shown. Quad post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Quad post racks shall have the following specifications:
 1. Depth adjustment: rack rails shall be adjustable from 12.5" to 36" in depth, independent of the structural members allowing racks rails adjustment after racks are anchored.
 2. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
 3. Rack rails type: standards EIA/ECA 19" square holes located in the front and back of rack. Rack rails shall have RU marked and labeled.
 4. Rack screw type: cage nuts clipped to rack rails. Nuts and screws shall be provided for all slots in rack rails and shall be made of steel threaded as #10-32.
 5. Weight capacity: UL listed for 1200 lb or more.
- B. Quad post racks shall be provided with the following accessories:
 1. Base dust covers that prevent accumulation of dust and debris in rack base.
 2. Cable runway mounting brackets to support cable runway installed above racks
 3. Isolation pads.
 4. Grounding kit.
 5. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threaded holes 1032 mounted to the cabinet using nylon insulation washers
 6. End panels to support vertical wire managers at the end of each rack row.
- C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
 1. Style: Metal cage with dual hinged door cover [cage with latches] [finger-duct with removable covers] [D-rings]
 2. Sides: single sided wire manager (front only).
 3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in [48 sq-in] [24 sq-in]. [16 sq-in].

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4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
1. Style: Metal cage with dual hinged door cover [cage with latches] [finger-duct with removable covers] [D-rings]
 2. Sides: single sided wire manager (rear only).
 3. Capacity: Usable cross sectional area shall be a minimum of: 130 sq-in [48 sq-in] [24 sq-in]. [16 sq-in].
 4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- E. Approved manufacturer: Match selection for Equipment Cabinets [Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal].

2.29 TWO POST RACKS (CHANNEL RACKS)

- A. Whenever indicated in the design drawings two post racks shall be provided as shown. Two post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Two post racks shall have the following specifications:
1. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
 2. Channel depth: 3" [6"] [10"] [16"] [24"] [30] \pm 1"
 3. Rack rails type: standards EIA/ECA 19" located in the front and back of rack. Rack rails shall have RU marked and labeled.
 4. Rack screw type: #12-24 threaded rack rails. Screws shall be provided for all openings in rack rails and shall be made of steel.
 5. Weight capacity: UL listed for 1000 lb or more.
- B. Two post racks shall be provided with the following accessories:
1. Cable runway mounting brackets to support cable runway installed above racks
 2. Isolation pads
 3. Grounding kit.
 4. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threaded holes 1032 mounted to the cabinet using nylon insulation washers
 5. End panels to support vertical wire managers at both ends of each rack row.
- C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
1. Style: Metal cage with dual hinged door cover [cage with latches] [finger-duct with removable covers] [D-rings]
 2. Sides: single sided wire manager or dual side wire manager.
 3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in [48 sq-in] [24 sq-in]. [16 sq-in].
 4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.

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- D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
1. Style: Metal cage with dual hinged door cover [cage with latches] [finger-duct with removable covers] [D-rings]
 2. Sides: single sided wire manager (rear only) or if dual side wire front managers are included, no need for rear vertical wire managers.
 3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in [48 sq-in] [24 sq-in]. [16 sq-in] [12 sq-in]..
 4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- E. Approved manufacturer: Match selection for Equipment Cabinets [Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal].

2.30 WALL MOUNTED RACKS

- A. Whenever indicated in the drawings, wall mounted racks shall be provided as indicated. Wall mounted racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Wall mounted racks shall have the following specifications:
1. Style: Swing out reversible cabinet [Fixed frame] [Frame with reversible swing out front panel]
 2. Height: As indicated in design drawings.
 3. Depth: it is the responsibility of the SCS installer to select a cabinet that will fit all equipment to be installed in the racks, either provided under this contract or by the owner. Approval of submittals by the A&E does not relieve the SCS installer of the responsibility of verifying this requirement. Racks that will not fit the equipment shall be replaced at no additional cost to the owner.
 4. Rack rails type: standards EIA/ECA 19" located in the front. Rack rails shall be adjustable and shall have RU marked and labeled.
 5. Rack screw type: #12-24 threaded rack rails. Screws shall be provided for all openings in rack rails and shall be made of steel.
 6. Weight capacity: UL listed for 200 lb or more.
- B. Wall mounted racks shall be provided with the following accessories:
1. Front perforated panel [Plexiglass] [Solid] door with lock. Door shall be hinged and shall be reversible.
 2. Fan kit composed of two 4" fans and fan guards.
 3. Additional rack rails shall be provided when equipment with a different of 2" in front depths are to be mounted in the rack. Front depth is defined as the distance between the front of the rack ears and the front of the equipment, including space for connectors or bend radius of cables.
 4. Grounding kit.
 5. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threaded holes 1032 mounted to the cabinet using nylon insulation washers.
- C. Approved manufacturer: Match selection for Equipment Cabinets [Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc. or approved equal].

2.31 MEDIA CONVERTERS

- A. General. When telecommunications outlets exceed distance limitations to pass testing requirements, the SCS installer shall provide media converters and fiber optics connectivity to overcome this problem. The media converters shall have the following specifications:
1. Power: All power for media converters in the field end (i.e. camera or WAP side) shall be powered from the Telecom room side using a hybrid cable. Local power adapters for media converters are not acceptable in the field end.
 2. Cabling: A composite cable shall be used for these devices. This composite cable shall have a minimum of 2 strands of fiber optics and 1 pair of copper cable AWG-12 for the remote end power. The quantity of fiber strands for this cable shall be as required by the type of media converter used. The fiber types shall be as required by the media converter. The cable jack for this composite cable shall be selected as required for the application. Any cables being pulled underground shall have a water blocking jacket.
 3. Port count: Media converters with 1 port or 4 ports are acceptable.
 4. PoE support: Media converters shall support PoE without the need of an external power adapter and the field end.
 5. Fiber connection speed. Media converters shall support 1GB connections in the fiber port.
 6. PoE capacity: Media converters shall support PoE+ (30W) for all outdoor cameras and all WAPs. Media converter shall support 15,4 W for all other PoE devices.
 7. Power supplies: Media converters shall be provided with the corresponding power supplies at the telecom room.
- B. Basis of design; Berk-Tek One Reach solutions or similar.

2.32 CABLE TIES

- A. Cable ties shall be used at different locations of the project but with the same goal of producing a neat and organized installation. Cable ties shall be used to support cables to j-hooks (when j-hooks are allowed in the project) to organize cables in ladder trays, D-rings and cable trays, to support cables to wire managers including managers behind patch panels, to bundle cables, organize patch cords, etc.
- B. To support and organize all horizontal cabling and inside premise backbone cables, only the following types of cable ties shall be used:
1. Hook and loop style, re-usable with Velcro no smaller than 0.5" width.
 2. Pre-perforated rolls of re-usable ties with Velcro no smaller than 0.5" width
 3. Straps of other soft materials with cinch rings that allow for re-use of the cable ties in widths no smaller than 0.85".
- C. Nylon based cable ties (re-usable or not) can only be used to support and organize the following types of cables:
1. Outside plant fiber and copper backbone cables.
 2. Inside premise fiber optic backbone cables with interlock armors.
 3. Grounding conductors
- D. Nylon based cable ties shall never be used to support or organize any type of horizontal cables or inside premise fiber optic backbone cable without armor.

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- E. All cable ties to be used in outdoor environments shall be made of weather resistant Acetal. Outdoor cable ties used for aerial cable lacing shall be in compliance with Telcordia TR-TSY-000789 standard.
- F. All cable ties shall be selected in lengths as to properly secure the bundle of cable being supported.
- G. All cable ties to be used in air handling spaces, such as above ceiling and under raised floor areas, shall be UL listed for the use in those environments.
- H. Approved manufactures: Ortronics, Panduit or approved equal

2.33 IDENTIFICATION AND LABELING TAGS

- A. SCS installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES.

- A. GENERAL. All installation requirements indicated in specification section 270010 shall be followed.
- B. WORKMANSHIP. All work shall be completed by the SCS installer in a neat and workmanlike manner. The use of all BICSI standards and recommendations for installation shall be followed as the benchmark for workmanship.
- C. CABLE LENGTHS. It is the SCS installer's responsibility to plan the cable routing in the cable tray and other raceways as to minimize all cable runs to be able to stay under the 90 meter (295 ft) length limitation for Horizontal Cabling. All cable runs exceeding the wiring distance, due to raceways run in not the most efficient way to minimize distance, shall be re-run with horizontal fiber optic cables and with media converters, at no extra cost to the owner.
- D. WIRE MAPPING. All terminations of 4-pair horizontal cabling in this project and terminations of all 4-pair patch cords shall be per T568A T568B standard.
- E. FIBER OPTICS TERMINATION POLARITY. All fiber optic cables (horizontal or backbone) terminated in duplex style adapter panels shall be connected in a cross-over polarity configuration. As an example, if fibers 1 and 2 are terminated in one end in positions A and B respectively in one side of the cable, the same strands shall be terminated in B and A positions in the other side of the cable.
- F. POLARITY FOR FIBER OPTICS ARRAY CONNECTORS. Array connectors and cassettes for this project shall use Method C polarity system as outline in TIA-568.B.1
- G. LOCATION OF HORIZONTAL TERMINATIONS. In a multi-story facility with telecommunications room in every floor, all horizontal drops, whether terminated in the wall or in floor boxes shall be terminated in the same floor telecommunications room as the location of the final outlet.

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- H. CABLE BUNDLES. In suspended ceiling and raised floor areas if duct, cable trays or conduits are shown on the contract drawings, the SCS installer shall bundle, in bundles of 40 or less, horizontal wiring with cable ties snug, but not deforming the cable geometry. The cable bundling shall be supported via "CLIC" fasteners in TR's and non-plenum areas and J-hooks in ceiling spaces. The SCS installer shall adhere to the manufacturers' requirements for bending radius and pulling tension of all cables.
- I. CLIC FASTENERS: Horizontal cables shall be suspended by "CLIC" fasteners with cable inserts in TR's on the plywood area where ladder tray or rack management is not available per the design documents. Listings: "CLIC" fasteners shall be in accordance with NEC and BICSI standards. Above the plywood area J-hooks or D-rings should be used.
- J. FIRE STOP PROTECTION: Sealing of openings between floors, through rated fire and smoke walls, existing or created by the SCS installer for cable pass through shall be the responsibility of the SCS installer. Sealing material and application of this material shall be accomplished in such a manner, which is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the SCS Installer's work. Any openings created by or for the SCS installer and left unused shall also be sealed as part of this work. Penetration rating shall equal structure rating.
- K. NEW MATERIALS: All components, wiring and materials to be used for the installation of the SCS shall be new and free of defects. Used components, wiring and materials shall only be used when specifically indicated in the design drawings.
- L. DAMAGE: The SCS Installer shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces including painting and ceiling tile replacement shall be included as part of this contract.
- M. AVOIDING EMI: To avoid EMI, all pathways shall provide clearances of at least 4 feet (1.2 meters) from motors or transformers; 1 foot (0.3 meter) from conduit and cables used for electrical-power distribution; and 5 inches (12 centimeters) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The SCS installer shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
- N. WORK EXTERNAL TO THE BUILDING: Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.
- O. DEMOLITION. Any task part of the installation of the SCS requiring relocation, rerouting and/or demolition shall be done according to the following requirements:
 - 1. Coordination: Prior to any deactivation and relocation or demolition work, arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused or to remain in operation and be integrated with the new systems.
 - 2. Provisions: All deactivation, relocation, and temporary tie-ins shall be provided by the SCS installer. All demolition, removal and the legal disposal of demolished materials of system designated to be demolished shall be provided by the SCS installer.
 - 3. All Existing Voice/Data cables and connecting hardware not to be used after the new installation is complete and within the areas where work is required as part of this project

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- shall be removed by the SCS installer. All existing cables to be left for future use if indicated by the owner shall be tagged for that purpose.
4. Owners Salvage: The Owner reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
 5. Phasing: The SCS installer shall perform all work in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.
- P. ICONS. Faceplates, jacks or patch panels with inserts for icons shall be filled with icons when unit capable of accepting icons. Icons in the work area side (outlet) shall match the color of the faceplate. Icons for path panels shall match the color of the horizontal cabling.
- Q. BLANK INSERTS AND PANELS. All telecommunications outlets with faceplates or mounting frames with unused terminations shall be plugged with blank inserts or panels. Blank inserts shall match the color of the faceplate or mounting frame. No more than one blank module shall be required for each faceplate. All unused ports in the FODC enclosures for adapter panels shall be filled with blank adapter panels.
- R. PATCH PANEL AND FODC SEPARATION: Horizontal cables shall be terminated in separate patch panels according to the use of the cable. Each series of patch panels or FODC for a specific use shall have at least 20% spare capacity of ports. Patch panels of the same use shall be mounted consecutive in the equipment cabinets or racks. The following separation for patch panels and FODCs shall be provided:
1. Cables for Wireless Access Points (WAPS) shall be separated from cables for any other purpose.
 2. Cables for surveillance cameras shall be separated from cables for any other purpose.
 3. Cables for voice drops shall be separated from cables for data drops.
 4. Cables for any other specialty systems like security systems, nurse call systems or others shall all be terminated in separate patch panels from any other cables.
 5. Horizontal fiber optic cables shall be terminated in separate FODC from fiber optics backbone cables.
 6. Single mode fiber optic backbone cables shall be terminated in separate FODC from multimode fiber optic backbone cables.
- S. SUPPORTS FOR REAR OF PATCH PANELS. All patch panels for horizontal cables shall be provided with a rear support bar to hold the cable and to provide strain relief. At a minimum one rear support bars shall be provided for each two rows of 24 connectors.
- T. HORIZONTAL WIRE MANAGERS. Horizontal wire managers shall be provided following this criteria:
1. At least one above and below each straight (flat) patch panel.
 2. At least one top and bottom of each series of angled or curved patch panels.
 3. At least one above and below any network switches.
 4. At least one below any rack mounted termination block.
- U. CROSS OVER WIRE MANAGERS. Cross over wire managers shall always be used with angled or curved patch panels. One cross over wire manager shall always be installed in the middle of each rack at the same height on every rack.
- V. PATCH CORD QUANTITY, COLOR AND LENGTHS. Copper and fiber optics patch cords shall be provided per following chart. All percentage calculations shall be rounded off to the nearest integer number.

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TYPE	QTY	COLOR JACKET	LEGTH
4-pair at work area outlet	One for 90% of all 4-pair horizontal cables in the project	Match horizontal cable color jacket specified.	30% 8', 50% 10' and 20% 14'
4-pair at WAP location	One for 100% of all 4-pair horizontal cables for WAPS in the project + 10% spare	Match horizontal cable color jacket specified.	The SCS installer shall field verify all lengths to match location of WAPS selected by owner or wireless survey. For pricing purposes use 12'
4-pair at Surveillance camera	One for 100% of all 4-pair horizontal cables for cameras in the project +10%	Match horizontal cable color jacket specified.	The SCS installer shall field verify all lengths to match location of cameras. For pricing purposes use 12'
4-pair at patch panel side (excluding surveillance cameras and WAPS)	One for 90% of all 4-pair horizontal cables in the project	Match horizontal cable color jacket specified.	For pricing purposes use: 40% 6', 40% 8', 20% 12'. SCS installer shall field verify these percentages to provide more accuracy.
4-pair at patch panel side (surveillance cameras and WAPS)	One for 100% of all 4-pair horizontal cables in the project +10%	Match horizontal cable color jacket specified.	For pricing purposes use: 40% 6', 40% 8', 20% 12'. SCS installer shall field verify these percentages to provide more accuracy.
2-strand fiber optics at work area outlet	One for 100% of all 2-strand horizontal fiber cables in the project + 10% spare	Per fiber type	50% 8' and 50% 10'
2-strand fiber optics at FODC.	One for 100% of all horizontal 2-strand fiber cables and one for 83% of all fiber strands of backbone cables in the project. For example a 24 strand cable shall require 20-2-strand patch cords or 10 for each side of the cable	Per fiber type	For pricing purposes use: 20% 6', 60% 10'. 20% 14' SCS installer shall field verify these percentages to provide more accuracy.
One or two pair for copper backbone cross connects	One for 90% of all backbone copper pairs installed in the project.	Gray	For pricing purposes use: 80% 8', 20% 10'. SCS installer shall field verify these percentages to provide more accuracy.

W. CABLE SLACK. Cable slack shall be provided for all cables in the project following this guideline:

1. At each work area outlets, all horizontal cables shall have 12" of slack.

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2. At the telecom room side all horizontal cables shall have at least 6' neatly organized on the wall using a figure 8 configuration or a non-loop shaped arrangement with Velcro straps.
 3. Backbone cables at termination points shall have at least 15' of slack neatly organized on the wall using a standard loop and Velcro straps.
 4. Outside plant backbone cables run through in-ground pull boxes greater than 24"X24" shall include one service loop inside the box.
- X. BEND RADIUS. Installation of Fiber Optic Cables shall be in accordance with ANSI/TIA-568C guidelines and cable manufacturer specifications. Bend radius parameters shall be followed for load and no load conditions. Cable installation and terminations that do not comply shall be replaced by the SCS installer. If no recommendation is specified by cable manufacturer, at least the following criteria shall be met:
1. The bend radius for intrabuilding 2 and 4-fiber horizontal optical fiber cable shall not be less than 25 mm (1 in) under no-load conditions. When under a maximum tensile load of 222 N (50lbf), the bend radius shall not be less than 50 mm (2 in).
 2. The bend radius for intrabuilding optical fiber backbone with fiber counts above 4 shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 15 times the cable outside diameter when the cable is under tensile load.
 3. The bend radius for interbuilding optical fiber backbone shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 20 times the cable outside diameter when the cable is under tensile load up to the rating of the cable, usually 2670 N (600lbf).
- Y. INNERDUCT. Innerduct shall be provided from end to end of a raceway system under the following conditions:
1. Inside underground conduits as indicated in design drawings.
 2. For horizontal fiber optic cable or inside premise fiber optics backbone cables without interlocking armor when routed through cable trays, ladder trays, vertical conduit sleeves or conduits larger than 3". This requirement is usually not indicated in the drawings but indicated only in this specification.
- Z. SCS PROTECTION DURING CONSTRUCTION. The SCS installer shall protect all SCS materials from damage during construction. Racks shall be covered with fabric or plastic after mounting to prevent dust, debris and other foreign materials having contact with SCS devices. The SCS installer shall protect at all times all fiber optic and copper cables from damage during installation. All cables shall maintain the physical integrity as manufactured for testing and delivery to the owner. All damaged cables shall be replaced at no additional cost to the owner.
- AA. CABLE BONDING. Shielded cables or cables with metal strength or protection members (like interlocking armor) shall be bonded to the telecommunications grounding system as indicated in specification section 270526.
- BB. RACK INSTALLATION. All racks shall be installed leveled and plumbed. Four post racks and two post racks shall be anchored to the floor and shall be installed with isolation pads. Equipment cabinets shall be leveled using the leveling feet unless design drawings specifically indicate to leave them on the casters.
- CC. RACK BONDING. All equipment cabinets and racks shall be bonded to the telecommunication grounding system as indicated in specification section 270526

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3.2 IDENTIFICATION AND TAGGING

- A. General: Identification and tagging of SCS components shall be executed by the SCS installer. At a minimum identification and tagging shall be provided for the following components of the system:
1. All horizontal and backbone cables at both ends of the cable in the cable jacket. Labels on each side shall be different indicating the location of the other side of the cable
 2. All faceplates indicating all jacks terminated in the faceplate.
 3. All patch panels.
 4. All racks
 5. All termination blocks
 6. All telecommunication rooms and outdoor enclosures.
 7. All interbuilding backbone cables inside in ground pull boxes outside of the building shall have a visible label in each box they pass through.
- B. The SCS installer shall follow the owner provided identification system. If owner does not have any preference or standard the SCS installer shall provide a system for approval of the A&E and the owner as indicated in the submittal paragraph of this specification. The identification system shall follow the ANSI/TIA 606-C standard.

3.3 TESTING OF COPPER CABLING

- A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA-568-C, Cabling Transmission Performance and Test Requirements.
- B. For all 4-pair copper cabling terminated for the use of building systems or system provided under the contract, such as surveillance cameras, emergency phones, elevator phones, WAPs, Access control panels and building automation equipment, the required test shall be a Channel style test. This means copper test shall be done with patch cords that will be used for permanent installation of those devices.
- C. For all 4-pair copper terminated for the use in work areas such as computers and phones, the test method selected for all 4-pair copper cabling is a permanent link style test. Permanent link test is defined as a test that does not include the patch cords to be used in the project.
- D. General: In the event the A&E elects to be present during the tests, provide notification to the engineer two weeks prior to testing.
- E. General: The installer's RCDD shall sign off on all copper and fiber optic cable test results, indicating that he/she was in responsible charge of all cable testing procedures and that all cables were tested in compliance with the contract documents and met or exceeded the requirements stated herein.
- F. Testing Equipment: Tester shall be as manufactured by Agilent, Fluke, IDEAL or Wavetek. Tester shall be 100% Level III Level IIIe compliant with ANSI/TIA 568C specifications for testing of the CAT6 CAT6A cabling. No tester will be approved without meeting these requirements.
- G. Each jack in each outlet shall be tested at a minimum to the manufacturer's performance of the cable to verify the integrity of all conductors and the correctness of the termination sequence.

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Testing shall be performed between work-areas and the equipment rack patch panel. Prior to testing UTP runs, the tester shall be calibrated per manufacturer guidelines. The correct cable NVP shall be entered into tester to assure proper length and attenuation readings.

- H. Documentation of cable testing shall be required. The SCS installer shall provide the results of all cable tests in electronic format (final results in PDF format and raw data). Each test page shall be separated by standard page break (one test per page). The test results shall include: sweep tests, continuity, polarity checks, wire map, Attenuation, NEXT, PSNEXT, FEXT, PSFEXT, ELFEXT, PSELFEXT, ACR, Return Loss, Delay Skew, and the installed length. Cables not complying with the ANSI/TIA 568C tests results shall be identified to the A&E for corrective action which may include replacement at no additional expense to the Owner. All identification names of the cables used in the test shall match the labeling system approved for the project and the corresponding shop drawings.
- I. Any Fail, Fail*, Pass* or WARNING test result yields a Fail for the channel or permanent link under test. In order to achieve an overall Pass condition, the result for each individual test parameter must be passed. All test results shall come from a tester with the permanently enabled marginal reporting feature.
- J. Test results shall show and comply with the margin claimed by the manufacturers over CAT6 CAT6A permanent link specifications on all transmission parameters across the entire frequency range as shown on the manufacturer's cut sheets.
- K. General: Copper multipair backbone cabling shall be tested for length, continuity, polarity checks and wire map. The SCS Installer shall provide the results of all Copper Riser cable tests in electronic format. The use of pigtails or special harness could be required to properly test these cables.
- L. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.
- M. All 4-pair patch cords shall be factory tested only.

3.4 TESTING OF FIBER OPTICS CABLING

- A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA 568-C and the addendum for fiber optic testing.
- B. General: In the event the Engineer elects to be present during the tests, provide notification to the engineer two (2) weeks prior to testing.
- C. Cleanness: All fiber optics connector shall be cleaned properly before any testing and after testing. Proof of cleanness shall be required during the acceptance test for the SCS by the A&E. SCS installer shall have available during this test a 200X microscope or a video probe to demonstrate the cleanness of the randomly selected connectors by the A&E.
- D. End to End Attenuation Test: The SCS installer shall perform end-to-end attenuation testing for each multimode fiber at 850 nm and 1300 nm from both directions for each terminated fiber span in accordance with ANSI/TIA-526-14A (OFSTP 14) and single-mode fibers at 1310 nm and 1550 nm from both directions for each terminated fiber span in accordance with ANSI/EIA-

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526-7 (OFSTP 7). A one jumper reference shall be used for all testing. For spans greater than 90 meters, each tested span must test to a value less than or equal to the value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be < 2.0 dB. When calculating the link loss budget for spans greater than 90 meters use the values listed below. End to end attenuation shall be done with a Level II meter using a meter and light source equipment (also known as main and remote unit)

ATTENUATION DUE TO	FIBER TYPE	MAX. ATTENUATION
Terminating connectors. Field terminated options	All fiber types	0.75 dB per connector
Terminating connectors, pre-term fibers	All fiber types	No more than 0.2 dB additional to total dB loss measured at the factory in report sent by cable manufacturer.
Splices	All fiber types	0.3 dB per splice
Distance	OM1 (850nm/1300)	3.4 dB /1.0 dB per Km.
Distance	OM2, OM3 and OM4 (850nm/1300)	3.0 dB /1.0 dB per Km.
Distance	OS1 and OS2 (1310 nm/1383 nm/1550 nm)	0.65 dB /0.65 dB/ 0.5 dB per Km.

E. OTDR Test. Additional to end to end attenuation test, all fiber optic cables shall be tested with a Level III OTDR equipment for the following conditions:

- Each known event (connector/splice) insertion loss at both windows for each fiber type (850/1300 nm for multimode and 1310/1550 nm for single mode). All events shall pass maximum allowed insertion loss for the event type as indicated in table above.
- Reflective events (connections) shall not exceed:
 - 0.75 dB in optical loss when bi-directionally averaged
 - 35 dB Reflectance for multimode connections
 - 40 dB reflectance for UPC singlemode connections
 - 55 dB reflectance for APC singlemode connections
- Non-reflective events (splices) shall not exceed 0.3 dB.
- Estimated distance for multiple strands of the same cable shall not vary more than 1% between strands.
- Cable signature in the form of traces along the complete distance of the cable. Unexplained cable reflections shown in the OTDR shall require the installer to submit letter explaining such events and pictures of cable conditions in the locations where the unexplained events are located to demonstrate cable has not been kinked or damaged during installation.

F. OTDR Test conditions. All OTDR testing shall be performed with the following conditions:

- Use a launch cable and a tail cable in accordance with fiber type being tested and requirements indicated by OTDR equipment manufacturer.
- Launch and tail cables shall be products sold by testing equipment manufacturer and not field made cables.
- Launch and tail cables shall be selected according to the type of connector being tested such as APC or UPC type connectors.
- Use launch compensation mode during the test to subtract the effects of the launch and tail cables.

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5. Test from one direction only, unless the presence of “gainers” are spotted during the test. In such case the installer shall test in both directions and adjust the test equipment to average measurements from both directions.
6. The SCS installer shall verify the backscatter coefficient use in the test to make sure it matches the coefficient of the cable being tested.

G. OTDR Testing Equipment used on this project shall have the specifications indicated in this following table:

SPECIFICATION	MULTIMODE	SINGLE MODE
Wavelengths	850 nm \pm 10 nm 1300 nm \pm 35 / -15 nm.	1310 nm \pm 25 nm. 1550 nm \pm 30 nm.
Event Dead Zone. Measured at 1.5 dB below non-saturating reflection peak with the shortest pulse width. Reflection peak $<$ -40 dB for mm and $<$ -50 dB for sm.	850 nm: 0.5 [3.7] m typical 1300 nm: 0.7 [3.5] m typical	1310 nm: 0.6 [3.5] m typical 1550 nm: 0.6 [3.5] m typical
Attenuation Dead Zone. Measured at \pm 0.5 dB deviation from backscatter with the shortest pulse width. Reflection peak $<$ -40 dB for mm. and $<$ -50 dB for sm.	850 nm: 2.2 [10] m typical 1300 nm: 4.5 [13] m typical	1310 nm: 3.6 [10] m typical 1550 nm: 3.7 [12] m typical
Pulse Widths (nominal)	850 nm: 3, 5, 20, 40, 200 ns. 1300 nm: 3, 5, 20, 40, 200, 1000 ns.	3, 10, 30, 100, 300, 1000, 3000, 10000, 20000 ns
Loss Threshold Setting	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments

- H. The Test Report for each fiber strand shall include the following information:
1. Calculated Loss Budget for each optical fiber link (see attenuation table above)
 2. Cable/strand ID matching shop drawings labeling system.
 3. Name of technicians who performed the test.
 4. Date and time the test was performed.
 5. Measurement direction (from/to)
 6. Jumper reference set up date/time and attenuation value
 7. Equipment model and serial number used and calibration date.
 8. End to End Attenuation Loss Data for each optical fiber link
 9. OTDR Traces, one page per strand. Expand chart to cover most of the page
 10. Each event loss data and test limits used, including test limit file date used.
- I. For fiber optic cables with factory terminated connectors or pre-terminated pig-tails, The SCS installer shall provide also the test results performed at the factory for fiber optic cables with factory terminated connectors to compare with the field test done by the SCS installer. No significant variation between the factory test results and the field test results shall be encountered.

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3.5 SYSTEMS WARRANTY AND SERVICE

- A. SCS Installer shall follow all warranty and service requirements indicated in specification section 270010.
- B. Warranty: The SCS shall be required to be under the manufacturer's warranty program for a complete channel configuration including cable, jacks, patch cords and patch panels and include cabling specifically approved for the channel configuration with the manufacturer's components. Manufactures shall provide the warranty worst-case performance data for the installed cabling system, and the performance data indicated in the warranty documents/certificate.
- C. A twenty five (25) year warranty available for the Structured Cabling System (Fiber optics and copper infrastructure) shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement thereof.
- D. Additional features of the warranty shall include:
 - 1. That the SCS installed system complies with the margin claimed by the manufacturer above the category 6 6A channel specifications on all transmission parameters across the entire frequency range of 1-600 MHz as shown on the manufacturers catalogs and literature.

3.6 SPARE PARTS

- A. As part of this contract the SCS installer shall provide the following spare parts.
 - 1. Ten (10) modular SCS jacks.
 - 2. Five (5) faceplates
 - 3. Two (2) faceplates with support post.
 - 4. Ten (10) fiber optic connector of each type used in the project.
- B. As part of this contract the SCS installer shall provide the following tools:
 - 1. Two (2) modular SCS jacks termination tools when modular SCS jacks required a manufacturer specific tool.
 - 2. One (1) punch down tool with a 110 blade and one 66 blade.
 - 3. One electric (1) cable finder.

3.7 COMISSIONING

- A. SCS Installer shall follow all warranty and service requirements indicated in specification section 270010.

3.8 ENGINEER'S FINAL ACCEPTANCE TEST

- A. SCS Installer shall follow all requirements for final acceptance indicated in specification section 270010.

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- B. The Engineer's final acceptance test will not include testing of structured cabling components, but could include verification of cleanness of fiber optic connectors.

3.9 TRAINING AND INSTRUCTION

- A. Training shall only be done after all testing, identification process and commissioning have been completed and passed as indicated in this specification. Any training done prior to final acceptance will not be accounted for the formal training requested and the SCS installer shall re-do all training after the final acceptance test is passed, at no additional cost to the Owner.
- B. SCS Installer shall follow all training requirements indicated in specification section 270010
- C. The training for the SCS shall include the following topics:
 - 1. Detail explanation of the identification system.
 - 2. A walkthrough of all spaces and locations where terminations have been done in the project.

3.10 AS BUILT DOCUMENTS AND PROJECT CLOSE OUT

- A. The SCS shall follow all requirements for as-build and close out documents indicated in specification section 270010
- B. The following are additional requirements supplementing the information provided in specification section 270010:
 - 1. Provide the Warranty certificate issued by the manufacturer of the SCS infrastructure.
 - 2. The installer's RCDD shall affix his/her stamp to the as-built drawings, indicating that he/she has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.
 - 3. As built drawings inside each telecom room. The SCS installer shall plot all as-built drawings and locate them inside each of the telecom rooms in the project. Each telecom room shall have the as-built drawings of the areas being served from that room. Each drawing shall be placed inside a clear vinyl document protector the size of the actual design drawing and affixed to a wall/plywood in the telecom room. The document protector shall be re-usable and shall allow the owner to replace the drawings as changes are done to the SCS infrastructure in the future. Without this information, substantial use of the system will not be provided to the installer.
 - 4. The SCS installer shall provide Excel software spreadsheet that defines the telecommunications outlet number, location, number of voice, data and special jacks. This database shall also provide the outlet patch panel connection to the riser/inter-floor cable, equipment, and telephone company demarcation circuit pairs as part of the as-built documentation.
 - 5. Electronic copies of all test results (copper and fiber). Electronic copies shall include raw data files and PDF files with results. PDF files shall be organized the following way:
 - a. All copper cables for cables terminating in one telecom room in a single PDF files with the name equal to the label used in the shop drawings for the telecom room where the cables are terminated.
 - b. All attenuation and OTDR test for all strands of a single cable shall be in one PDF file with the name corresponding to the Cable ID used in the shop drawings.

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END OF SECTION 271000

SECTION 274134 – BROADBAND DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. General: Telecommunications Drawings apply to work of this section. The overall and detailed Broadband distribution design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- C. General: Requirements indicated in the following standard apply to the work to be performed under this specification section:
 - 1. TIA-568-C.4 (July 2011) “Broadband Coaxial Cabling and Components Standard”. Including addendum and errata.
- D. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 270526 Grounding and Bonding for Telecommunications Systems
 - 4. 274135 CATV Headend

1.2 DEFINITIONS

- A. Agile Receiver: A broadband receiver that can be tuned to any desired channel.
- B. Broadband: For the purposes of this Section, wide bandwidth equipment or systems that can carry signals occupying in the frequency range of 54 to 1002 MHz. A broadband communication system can simultaneously accommodate television, voice, data, and many other services.
- C. Carrier: A pure-frequency signal that is modulated to carry information. In the process of modulation, it is spread out over a wider band. The carrier frequency is the center frequency on any television channel.
- D. CATV: Community antenna television; a communication system that simultaneously distributes several different channels of broadcast programs and other information to customers via a coaxial cable.
- E. CCTV: Closed-circuit television.
- F. CEA: Consumer Electronics Association.

- G. dBmV: Decibels relative to 1 mV across 75 ohms. Zero dBmV is defined as 1 mV across 75 ohms. $\text{dBmV} = 20 \log_{10}(V1/V2)$ where V1 is the measurement of voltage at a point having identical impedance to V2 (0.001 V across 75 ohms).
- H. DOCSIS. Data Over Cable Service Interface Specification. This is an international telecommunications standard that permits the addition of high-speed data transfer to CATV system.
- I. Headend: The control center of the master antenna television system, where incoming signals are amplified, converted, processed, and combined into a common cable along with any locally originated television signals, for transmission to user-interface points. It is also called the "Central Retransmission Facility."
- J. MATV: Master antenna television; a small television antenna distribution system usually restricted to one or two buildings.
- K. RF: Radio frequency.

1.3 DESCRIPTION

- A. Broadband Distribution Systems shall provide distribution of video, television signals to all selected spaces in the buildings. The system design anticipates increasing demands for expanded channel capacity. The system shall include, but not be limited to passive and active infrastructure like distribution amplifiers, directional couplers, taps and splitters as required to achieve a fully functional system.
- B. General: Provide, complete with all accessories, a complete distribution system as describe herein and as indicated on the drawings
- C. Standards: Distribution system components and overall system performance shall meet or exceed the following standards:
 - 1. Federal Communications Commission Technical Specifications Title 47, Part 76 as applied to cable television systems.
 - 2. TIA – 568.4 Revision D “Broadband coaxial cabling and components”
 - 3. TIA-606-C, “Administration Standard for Telecommunications Infrastructure” with addendum and errata.
- D. RFI: Special emphasis shall be placed on radio frequency interference (RFI) integrity as licensed radio services outside the cable system share the same frequencies designated for use within.
- E. Distribution of direct broadcast satellite service signals, which includes coordinating with Owner's selected service provider for installation of its dish-type antennas and processing the signals as needed to provide specified services combined into a single-feed point ready for connection into the distribution system. Obtain signal levels, and noise and distortion characteristics from service provider as the point of departure for system layout and final equipment selection.
- F. Intent of design drawings: The intent of the design drawings is to indicate the scope of work of the project and to allow the installer to properly bid the project. The design drawings are based

on estimated distances between devices. Once all cable are run, the installer shall measure the exact cable footages between equipment locations and shall adjust the calculations of the system to comply with the performance criteria indicated in this specification section. The installer shall change any taps, equalizers or directional couplers to match the modified calculations by the installer, at no additional cost to the owner.

- G. For all CATV head end specification and requirements see section 274135, this section only applies to the distribution part of the CATV system.

1.4 SERVICES SUPPORTED

- A. The system configuration will allow the forward distribution of the following incoming TV signals:
1. Analog channels from Cable provider
 2. Digital channels from cable provider
 3. High Definition channels from cable provider
 4. Digital Satellite TV.
 5. High Definition channels from Satellite TV
 6. Off – Air High Definition TV channels
 7. Internally generated programming in a central location
 8. Internally generated programming from any room with distribution outlets in the facility.
- B. The system bandpass shall allow for the following channel loading and forward distribution:
1. Sixty (60) channels from 47 MHz to 450 MHz.
 2. Seventy seven (77) channels from 47 MHz to 550 MHz.
 3. One hundred and ten (110) channels from 47 MHz to 750 MHz.
 4. One hundred and twenty nine (129) channels from 47 MHz to 860 MHz.
 5. One hundred and fifty two (152) channels from 47 MHz to 1000 MHz.

[USE NEXT, ONLY IF OPTION 8 WAS SELECTED FROM 1.5.A.8]

- C. The system shall allow for a return path with a loading of 3 channels from 5 MHz to 42 MHz.

1.5 INSTALLER QUALIFICATIONS

- A. Qualifications: The CATV installer installing this system shall be experienced in the design, installation, proof of performance testing and maintenance of broadband cable television systems comparable or larger in size and complexity to the system required on this project. Such experience shall be indicated in a list of successfully completed systems with the submittal for this system. Contact names and addresses for all references shall be provided.
- B. Equipment: The CATV installer executing this work shall own and maintain at least the following equipment for execution and maintenance of this system;
1. A CATV signal level meter capable of measuring levels between 5 and 1000 megahertz for both digital and analog channels. For example Blonder Tongue BTPPRO-1000.
 2. CATV Plant certification meter such as JDSU DSAM Wavetek Series Field Meter Model DSAM 6300
 3. A flat noise generator or sweep/marker generator capable of providing a calibrated output between 5 and 1000 megahertz.

4. An oscilloscope with a suitable RF detector for use in sweep testing system response.
 5. A return loss bridge and variable termination for on-site cable sweep testing prior to installation.
 6. A time domain reflectometer designed for operation into 75-ohm polyethylene dielectric cable for verification of installed cable.
 7. Composite test sets, simul-sweep equipment and other test systems capable of providing the required functions shall be considered equivalent to the equipment specified.
 8. A stripping/coring tool appropriate for 0.500" hardline cable or larger cables.
- C. Resume: A resume of personal cable television experience shall be submitted for the cable foreman, each splicer, each technician, and the system design engineer.
- D. Provisions: The CATV installer shall own and maintain all necessary equipment and tooling to properly provide the system in accordance with recommendations set forth by the manufacturers of each item of system equipment.

1.6 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Substitutions are allowed for this system only for active components, as long as they have exactly the same performance as the basis of design.

1.7 SHOP DRAWINGS AND SUBMITTALS

- A. The CATV installer shall follow all requirements for shop drawings indicated in specification section 270010.
- B. Additional information to be included in the shop drawings
1. Cut sheet of all devices to be provided as part of this systems. When multiple devices are in the same cut sheet, the installer shall highlight the specific part number to be used. Cut sheets of the following devices shall be provided:
 - a. All copper and fiber optic cables
 - b. All passive devices
 - c. All amplifiers to be used
 - d. All connectors
 - e. All outlets indicating colors
 - f. All surge suppressors
 - g. All fiber optics equipment
 2. Proof of installer qualifications per paragraph 1.5
 3. A list of all testing equipment owned by the installer as requested in this specification. The list shall include all make and model number of all devices and the last time they were calibrated.
 4. Drawings indicating all outlets in the project, with cable distances included, types of cables and how they are connected to the backbone system. The drawings shall include all pad and equalization calculations to the input of all amplifiers in the system.

1.8 GENERAL SYSTEM PARAMETERS

- A. Devices and products described below may or may not be required for the overall design. If such devices are required in the course of this project to achieve the design distribution parameter, the installer shall provide such devices as a part of their design solution and said devices shall be included as part of the installers package in the bid. These items would include those listed below as well as splitters, taps, couplers and pads.
- B. The CATV installer shall be familiar with the ANSI/SCTE standards and shall follow those standards during the installation process.
- C. Amplifiers: In most cases, the output from the amplifier shall be adequate for building distribution. However in larger building distribution systems, additional amplifiers will possibly be required. If such is the case, Input pad and equalizers shall be provided to compensate for short spacing and cable slope, respectively. Outputs shall be adjusted to the rated sloped output of the amplifier selection (typically 36 dBmv to 44 dBmv or rated output by equipment manufacturer) at the selected frequency range indicated in this specification section.
- D. Output: All outlets shall provide a minimum output of between +3 dBmv and +10dBmv for the complete frequency range specified in this section.
- E. Minimum acceptable distribution system performance at all outlets shall be as follows:
 - 1. RF Video Carrier Level: Between 3 and 12 dBmV.
 - 2. Relative Video Carrier Level: Within 3 dB to adjacent channel.
 - 3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 dB during a 60-minute period.
 - 4. Carrier Level Stability, Long Term: Level shall not change more than 2 dB during a 24-hour period.
 - 5. Channel Frequency Response: Across any 6-MHz channel in 54- to 220-MHz frequency range, referenced to video, signal amplitude shall be plus or minus 1 dB, maximum.
 - 6. Carrier-to-Noise Ratio: 45 dB or more.
 - 7. RF Visual Signal-to-Noise Ratio: 43 dB or more.
 - 8. Cross Modulation: Less than minus 50 dB.
 - 9. Carrier-to-Echo Ratio: More than 40 dB.
 - 10. Composite Triple Beat: Less than minus 53 dB.
 - 11. Second Order Beat: Less than minus 60 dB.
 - 12. Terminal Isolation from Television to Television: 25 dB, minimum.
 - 13. Terminal Isolation between Television and FM: 35 dB, minimum.
 - 14. Hum Modulation: 2 percent, maximum.
 - 15. RF FM Carrier Level: 13 to 17 dB below video carrier level.
 - 16. FM Frequency Response: More than the 88- to 108-MHz frequency range, signal amplitude is plus or minus 0.75 dB, maximum.
 - 17. FM Carrier-to-Noise Ratio: More than 24 dB.
- F. RF Leakage: Radio frequency leakage into the system shall be in compliance of all FCC rulings and regulations.
- G. Delay: Combined reverse and forward path chroma delay, as measured at the most distant bridged port, to the headend and or main distribution point in the building and back, shall not exceed 28 nanoseconds.

- H. The complete CATV distribution system shall be certified form compliance with DOCSIS 3.1.
- I. All TV outlets in the project shall be provided with one UTP Category cable terminated in an RJ-45 connector at the faceplate and at a patch panel in the telecommunications room side for IPTV. This cable shall be terminated in the same telecom room as the coaxial drop and shall have the same performance, warranty and installation methods described in specification section 27100 for all other voice/data drops in the project.

PART 2 - PRODUCTS

2.1 DISTRIBUTION AMPLIFIERS (NOT AT HEAD END)

- A. This amplifier shall be used only in the distribution system and shall have the following specifications:
 - 1. Frequency Range: As stated in paragraph 1.4. B of this section
 - 2. Forward gain: 43dB
 - 3. Gain Control Range: Greater or equal to 10dB
 - 4. Slope Control Range: Greater or equal to 8dB
 - 5. Input Return Loss: Greater or equal to 16dB
 - 6. Noise Figure: Greater or equal to 7dB
 - 7. Required output Level: 36/44 dBmV,
 - 8. Hybrid technology: Power doubling
 - 9. Input/Output Test Point Level: -30dB
- B. Design Selection: Blonder Tongue BIDA 5900 series, or approved equal with required pads and equalizers.

2.2 DISTRIBUTION AMPLIFIERS (NOT AT HEAD END) FOR LARGER SYSTEMS

- A. This amplifier shall be used only in the distribution system and shall have the following specifications:
 - 1. Forward Frequency Range: 54 to 1000 MHz
 - 2. Reverse Frequency Ranfe: 5 to 42 Mhz
 - 3. Forward gain: 35dB
 - 4. Reverse gain: 20 dB
 - 5. Gain Control Range: Through plug in pads
 - 6. Slope Control Range: Through plug in equalizer
 - 7. Input Return Loss: Greater or equal to -16dB
 - 8. Noise Figure: Greater or equal to 6dB
 - 9. Composite triple beat (CTB): -78 dBc
 - 10. Composite Second order (CS)) -74 dBc
 - 11. Required output Level: 37/47 dBmV,
 - 12. Hybrid technology: Power doubling
 - 13. Input/Output Test Point Level: -20dB
- B. Design Selection: Toner TBLE-1035-42, or approved equal with external power supply and required pads and equalizers.

2.3 PASSIVE DEVICES

- A. All passive devices shall have a minimum bandwidth of 5 to 1000 MHz.
- B. Splitters for drops or backbones designed with RG-6 or RG-11 lines: Splitters shall be Blonder Tongue SXRS-2, 3, 4, 6 & 8 as required by the system configuration.
- C. Directional Couplers for drops or backbones designed with RG-6 or RG-11 lines: shall be Blonder Tongue SRT series, with dB TAP setting as required by the system configuration.
- D. Splitters for backbones designed with PIII-500 or bigger diameter cable: shall be Toner TLP-SP series as required by the system configuration.
- E. Directional couplers for backbones designed with PIII-500 or bigger diameter cable: Shall be Toner TLP-DC series as required for the system configuration
- F. Multi-taps shall be Toner Total tap with 3 or 6 tap housings as indicated by the system configuration. Tap values and quantity of tap ports as indicated in system configuration
- G. Equalizer. Equalizer shall be mounted in the tap housings and shall be a Toner TXMT plate. Equalizers could be mounted also inside distribution amplifiers. The value to equalize shall be as indicated in system configuration.

2.4 OUTLETS

- A. The television outlet shall provide (1) "F" type barrel connector mounted alone or with other structured wiring connectors on a common face plate. Outlets shall be mounted as indicated on the documents, or as otherwise indicated and directly inline with the proposed television location. Coordinate final location based upon provided drawings and coordination with the Owner. A three wire grounded, 120 VAC power outlet shall be located adjacent to the television outlet and be provided by owner selected Division 26 Installer. Coaxial cable shall be provided by the CATV installer to each outlet location indicated on the drawings. Conduit and boxes shall also be provided according to specifications section 270528. Coordinate location with electrical installer if not already provided at time of installation of this work.
- B. Design selection: F- connector with a single barrel connector to match (faceplate style and color) de design selection of the structured wiring system as described in specification section 271000. The outlet shall be a Blonder Tongue TF-GF-FT or similar with a dingle barrel connector.

2.5 VIDEO DISTRIBUTION CABLE

- A. Structural Return Loss Testing: All cable shall be 100% swept tested. Return loss shall not be less than 23dB at any given frequency between 5MhZ and 1000MhZ.
- B. Construction: Cable shall be constructed of a copper clad steel or solid copper center conductor, gas expanded cellular polyethylene dielectric, multiple aluminum braided shields, and an overall jacket. All cables shall have characteristic impedance of 75 Ohms.

- C. Attenuation: Attenuation characteristics in decibels per 100 feet at 20oC shall not deviate more than 10% from the following values:

FREQUENCY (MHz)	RG-6	RG-11	PIII-500
5	0.57	0.36	0.16
55	1.5	0.95	0.54
211	2.87	1.81	1.09
300	3.43	2.17	1.31
400	4.0	2.53	1.53
450	4.28	2.69	1.63
550	4.76	3.01	1.82
750	5.62	3.58	2.16
870	6.09	3.9	2.35
1000	6.54	4.23	2.53

- D. RG-6 Cable: No 18 AWG solid bare copper conductor. Four layers of shield, two aluminum foil-polyester tape aluminum foil, one 60% aluminum braid and one 40% aluminum braid. NEC article 820 compliant jacket suitable for the environment being installed.
- E. RG-11 Cable: No 14 AWG solid bare copper center conductor. Two layers of shield, one aluminum foil-polyester tape aluminum foil and one 60% aluminum braid. NEC article 820 compliant jacket suitable for the environment being installed.
- F. PIII-500: 0.109” diameter copper clad center conductor. Solid aluminum tube swaged onto a high compression micro-cellular foam dielectric core. NEC article 820 compliant jacket suitable for the environment being installed.
- G. Indoor Cables: The following table indicates the design selection for all CATV cables. Cables shall be selected according to the environment in which they will be installed:

CABLE TYPE	GENERAL (CM)	RISER RATED	PLENUM RATED
RG-6	Belden 5339Q5	Use plenum rated cable	Belden 6339Q8
RG-11	Belden 1617A	Use plenum rated cable	Belden1617AP
PIII-500	Use riser rated cable	Commscope P3 500 JCAR	Commscope P3 500 JCAP

- H. Outdoor Cables: When coaxial cables are to be installed outdoors, or underground in conduit, they need to have a jacket with a water blocking compound.
- I. RG-59 cable shall never be used for the distribution system.
- J. For all fiber optic cables and connector for broadband distribution see specification section 271000. All connector for fiber optic cables shall be APC (Angled polished connectors) type connectors.
- K. For all 4-pair category cable runs used for IPTV or video distribution, all requirements and specifications indicated in specification section 271000 shall be followed.

2.6 CONNECTORS AND ADAPTER

- A. Site Cable Connectors: All connector shall be as recommended by the Cable manufacturer for the cable size and jacket of the cable.
- B. Connectors for RG-6 cables. All connectors for RG-6 cable shall be one piece compression connectors with color coded sleeve. Design selection: Belden part number SNS1P6QS or equivalent.
- C. Connectors for RG-11 cables. All connectors for RG-11 cable shall be one piece compression connectors with color coded sleeve. Design selection: Belden part number SNS1P11 or equivalent.
- D. Connectors for PIII-500 cables. All connectors for PIII-500 cable shall use a 5/8" 3 pin type connector. Design selection: Amphenol ACC-500-CHT10 or equivalent.
- E. Adapters. The installer shall provide all adapters to connect all different cables listed above to an F type connector or a to a 5/8" 3 pin connector, as required in the design to make complete connections. Design selection: Amphenol ACC series or equivalent.
- F. Crimping: All connectors shall be installed using the connector manufacturer's recommended cutting, coring and pin crimping tools.

2.7 SURGE SUPPRESSION

- A. All coaxial cables entering or exiting a building (above or below ground) shall be surge protected as required by NEC article 820.
- B. All surge suppression devices shall be grounded with an AWG-12 isolated wire to the closest electrical ground.
- C. All surge suppression devices shall be UL 497 listed, gas tube suppression, power passing and specifically designed for broadband network applications.
- D. Design selection: TII in-line coaxial lightning surge protector part number 212FF757225-31.

2.8 FIBER OPTIC BROADBAND TRANSMITTER

- A. The fiber optic broadband transmitter (FOBT) shall be able to transmit broadband signals over a single mode fiber optic link and shall be able to accommodate a variety of different modulation formats such as AM/VSB, 8VSB, QAM, QPSK, etc. The FOBT shall use a high-power, low noise 1310 nm distributed feedback (DFB) laser diodes to transmit the signals.
- B. The specifications of the FOBT shall be:
 - 1. Channel loading: Same bandwidth as requested in part 1.4.B of this specification section.
 - 2. Operating Wavelength: 1310 nm
 - 3. Required Fiber Bandwidth: 1,000 Min. MHz
 - 4. Input Return Loss: ≥ 16 dB @ 75 Ohm
 - 5. Back Reflection: ≤ -50 min. dB
 - 6. Optical Output Power: as indicated in design documents.

7. RF Input Level (110 Ch. Load): + 18 dBmV/Ch
8. CNR (-1 dBm Input, 77 Ch. Load + QAM 550-860 MHz @ -6dB Ref. Analog): ≥ 52 dB
9. CTB: ≥ 69 dB
10. CSO: ≥ -63 dB
11. Side Mode Suppression Ratio (SMSR): 30 dB
12. Fiber optic connector type: FC (APC) single mode
13. Mounting: rack mounted with built in power supply.

C. Design selection: Blonder Tongue FIBT series or equivalent.

2.9 FIBER OPTIC BROADBAND RECEIVER

- A. The fiber optic broadband receiver (FOBR) shall be able to receive and forward incoming broadband signal and transmit sub-band signal back to the head end over a pair of single mode fiber optic links and shall be able to accommodate a variety of different modulation formats such as AM/VSF, 8VSF, QAM, QPSK, etc.
- B. The optical specifications of the FOBR shall be:
 1. Operating Wavelength: 1310/1550 nm
 2. Optical Input Range: -8.0 to +2.0 dBm
 3. Return laser power: 4.8 dBm, 3 mW
 4. Input Connector: SC/APC single mode
- C. The RF specifications of the FOBR shall be:
 1. CNR: > 52 dB
 2. CSO: > 65 dBc
 3. CTB: > 68 dBc
 4. Forward bandwidth: 54-870 MHz
 5. Return RF bandwidth: 5- 42 MHz
 6. Connector: type F.
- D. The fiber optics broadband receiver shall always be used in conjunction with a Distribution amplifier (not at head end) to amplify the signal to be sent to the outlets.
- E. Design selection: Blonder Tongue FOCN series with return path and DFB laser, and shall be provided with a power supply inserter.

2.10 FIBER OPTIC SUB-BAND RECEIVER

- A. The fiber optic sub-band receiver (FOSR) shall be able to receive and forward return path broadband signal coming from the FOBR over a single strand fiber optic links.
- B. The optical specifications of the FOSR shall be:
 1. Operating Wavelength: 1310 nm
 2. Optical Input Range: -9.0 to +4.0 dBm
 3. Input Connector: FC/APC single mode
- C. The RF specifications of the FOSR shall be:
 1. CNR: > 50 dB

2. CSO: -70 dB
3. CTB: -63 dB
4. Forward bandwidth: 5-400 MHz
5. Connector: type F.

D. Design selection: Blonder Tongue SIBR-S4A-210.

2.11 FIBER OPTIC BROADBAND COUPLER

- A. The fiber optic broadband coupler (FOBC) shall be a passive device capable of splitting a broadband signal modulates in a fiber optic signal to multiple outputs.
- B. The specifications of the FOBC are:
1. Number Of Inputs: 1
 2. Wavelength: 1310 & 1550 nm
 3. Number of Outputs: As indicated in design drawings
 4. Connectors: FC/APC.

Number of Outputs	2	3	4	6	8
Insertion Loss (Individual Port):	≤3.6 dB	6.0 dB	7.3 dB	9.7 dB	10.8 dB
Uniformity:	≤0.6 dB	1.0 dB	1.0 dB	1.0 dB	1.9 dB
Directivity:	≥ 50 dB	≥ 50 dB	≥ 50 dB	≥ 50 dB	≥ 50 dB

C. Design selection: Blonder Tongue FOC-22 series.

2.12 IDENTIFICATION AND LABELING TAGS

- A. The CATV installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. The CATV installer shall follow all installation practices indicated in specification section 270010
- B. In Raceway: All cables shall be installed in raceways without kinks, dents, or abrasions. Specified pulling strength of cable shall not be exceeded.
- C. All indoor cables shall have no splices at any points.
- D. Terminal Locations: Cables at terminal locations shall be neatly formed using a bending form to prevent kinks or other discontinuities. Cables showing evidence of abuse or physical damage shall be replaced at the installer's expense.

- E. It is envisioned that television service will migrate into the overall telecommunications scheme for a given facility, therefore television distribution shall be accomplished via the following methods. In general, television distribution points shall be located throughout the facility such and all wiring shall be run back to the Telecommunication closet where the connection to the Broadband distribution backbone will take place. In general television distribution points shall be located throughout the facility such and all wiring shall be wired in a tapped Trunk configuration with all taps above the ceiling in accessible common spaces.
- F. The facility contains telecommunications rooms or associated closets, which shall be used for amplification & distribution equipment as well as all TRUNK/FEEDER & DROP cable terminations. Cabling used shall conform to the specifications as previously outlined, with the addition of CMP type cables for use in plenum rated areas if applicable, and environmental air circulation spaces, if required by the facility air distribution system.
- G. All unused outputs of splitters, directional couples or distribution taps shall have a 75 ohm termination installed.
- H. All unused cavities of the Toner Total Tap housing shall be filled with blank plates
- I. All equipment with a grounding lug shall be grounded as recommended by the equipment manufacturer to an acceptable grounding point as described by the NEC.
- J. All amplifiers shall be used at the rated output. The installer shall provide the required equalization and attenuation pads for all amplifiers to operate at the rated output at only 80% of the maximum gain control of the unit.
- K. Cable and equipment identifiers shall be provided and shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CATV installer shall be submitted for approval to the A&E.
- L. The installer shall use attenuator or adjustment for fiber optic equipment to ensure proper budget levels are getting to each receiver.

3.2 INSTALLATION OF CONNECTORS

- A. Provisions: All connectors shall be installed in strict accordance with the manufacturers' instructions.
- B. Residue Removal: All dielectric residues shall be removed from surfaces of center conductors to insure proper electrical contact.
- C. Preparation: Semi-rigid cables shall have jacket removed to a length of 2" from the cable end to allow proper seating of connectors without scoring of the aluminum sheath. A tubing cutter shall not be used for this purpose. All flooding compound shall be removed from the connector location with a suitable solvent.
- D. Connections: All connections including terminations and connections on flexible cables shall be wrench tightened to insure RFI integrity. Connectors at manhole or exterior pedestal tap locations and antennas shall be filled with Dow Corning #5 compound prior to wrench tightening.

- E. Tooling: Cables shall be prepared to accept connectors using the manufacturer's recommended tooling.
- F. Crimp Connections: Crimp type connections on flexible cables in manholes shall be made with a Hex crimp tool and encapsulated with flooded heat shrink tubing.
- G. Heat Shrink Boot: All cables containing flooding compound shall be provided with a heat shrink boot at all termination points which covers the housing connector boss, body of the connector and extends not less than 12" along the cable jacket. Heat shrink boot shall be of the filled type.
- H. Splices: Cable splices below grade or in other locations shall be made according to manufacturers' recommendations, tested, and covered with a filled heat shrink boot approximately 30" in length. Boot shall contain a resilient compound which melts as heat is applied and fills all voids between the shrink tube and cable jacket. Resin casts shall not be acceptable.
- I. For termination of all Fiber optics and UTP category cable, follow all requirements indicated in specification section 271000.

3.3 EQUIPMENT MOUNTING

- A. Mounting: All remote terminal equipment (amplifiers, taps, couplers etc.) shall be neatly arranged and securely mounted. When installed above the ceiling all devices need to be in accessible places. All accessories required for wall mounting equipment shall be provided when equipment is to be wall mounted.
- B. Integrity: All equipment housing hardware including amplifiers shall be wrench tightened to insure full RFI integrity.

3.4 SYSTEM ADJUSTMENTS

- A. Installation: System design drawings are based on estimated distances between devices. The installer shall measure the exact cable footages between equipment locations and submit a revised drawing to the engineer for review containing the following;
 - 1. Exact footage of each cable
 - 2. Revised coupler and tap values
 - 3. Revised equalizer and pad values.

3.5 SYSTEM PERFORMANCE

- A. General: Upon completion the system shall be adjusted, tested, and left in perfect operating condition.
- B. Provisions: The system shall not exhibit any audible or visible components of hum, noise, or distortion.
- C. Before the system acceptance test, the installer shall test all outlets in the system and document the result in a spreadsheet or an automated test print out from the test equipment. This report is

called TEST RESULT REPORT (TRR). The TRR report shall include the following information:

1. Project name and location
2. Day test was done (if done in different days, the report shall be broken in sections by days the tests were done).
3. Name of the installer that performed the test
4. Serial number of the tester used.
5. For each outlet in the project the report shall include:
 - a. Room number:
 - b. Room name:
 - c. Outlet number (with permanent label matching as-built drawings)
 - d. Lowest channel - signal level (in dBmV)
 - e. Mid bandwidth channel – signal level (in dBmV)
 - f. Highest channel (as identified in part 1 of this specification) – signal level (in dBmV)
6. For each amplifier in the system the report shall include:
 - a. Room number:
 - b. Room name:
 - c. Lowest channel - signal level (in dBmV, measured @ test port)
 - d. Mid bandwidth channel – signal level (in dBmV, measured @ test port)
 - e. Highest channel (as identified in part 1 of this specification) – signal level (in dBmV, measured @ test port)

- D. All Fiber optics cables and UTP category cable shall be tested in accordance to specification section 271000.

3.6 SYSTEMS WARRANTY AND SERVICE

- A. General: The CATV installer shall follow all warranty and service requirements indicated in specification section 270010.

3.7 ENGINEER’S FINAL ACCEPTANCE TEST

- A. General: The CATV installer shall follow all test requirements indicated in specification section 270010.
- B. General: The Installer shall demonstrate the operation of the system to the Architect & Engineer (A&E) during the final inspection in the following manner:
1. Measure signal levels with a calibrated field strength meter at outlets and or amplifiers selected by the A&E. At a minimum 5% of all outlets will be tested. The readings of the meter shall be between 1.5 dBmV of the value documented in the TRR
 2. Observe picture quality at outlets selected by the Engineer using a television receiver.
- C. If at least one measurement fails, the A&E can request to the installer to test more outlets (beyond the 5% indicated previously) until the A&E is satisfied with the results. Any failures shall be corrected by the installer at no additional cost to the owner.

3.8 TEST EQUIPMENT REQUIRED

- A. At a minimum during the acceptance test to the A&E the installer shall have the following equipment:
 - 1. TV Receiver: 17" minimum diagonal screen size color receiver in good working order.
 - 2. Signal Meter: This signal meter needs to be the same tester used during the TRR
- B. Age and Calibration: Test equipment used in demonstrating system performance shall be less than 6 months old or bear the calibration seal of a recognized lab which is dated within 6 months of the date of acceptance test.

3.9 TRAINING AND INSTRUCTION

- A. General: The CATV installer shall follow all training requirements indicated in specification section 270010.
- B. The training shall include the following topics:
 - 1. How to make connectors part of this system with the provided tools.
 - 2. How to balance the system with amplifiers at rated output
 - 3. A walk-through of the facility pointing out the location of all active and passive equipment part of this system and showing to the owner the as-built drawings with matching labels for those pieces of equipment.
 - 4. A complete training on the use of the test tool provided.

3.10 SPARE PARTS AND TOOLS

- A. As part of this contract the installer of this system shall provide the following materials and tools:
 - 1. Twenty (20) RG-6 connectors, same make and model as the units used in this project.
 - 2. A new and unused crimping tool for the RG-6 connector specified.
 - 3. A new and unused coaxial cable stripping tool
 - 4. Five (5) 75 Ohm terminators (f connector)
 - 5. One (1) 5/8" 75 Ohms terminator.
 - 6. One (1) signal level meter as the one used for the TRR
 - 7. Two (2) surge protectors.

3.11 AS BUILT DOCUMENTS AND CLOSE-OUT INFORMATION

- A. General: The CATV installer shall follow all as built and close out information requirements indicated in specification section 270010.
- B. General: As built drawings shall include the following information:
 - 1. A block diagram of the entire system indicating all cable routing and lengths
 - 2. Revised coupler and tap values for each cable drop
 - 3. All cable types, active components, and passive components.
 - 4. All equalizing and attenuating pads used for each amplifier.
 - 5. All system settings.
 - 6. All brands and part number of all devices shall be indicated in the drawings.

7. Location of each outlet and the unique label identifier of each outlet.
 8. High/low signal level measured at each amplifier test port.
- C. Additional information to be provided by the CATV installer, as part of the close out information:
1. A copy of the TRR signed approved by the A&E.

END OF SECTION 274134

SECTION 275113 PUBLIC ADDRESS/BACKGROUND MUSIC SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: The following documents, apply to work of this section:
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 271000 Structured Cabling System
 - 4. 270526 Grounding and Bonding for Communication Systems
- B. General: Telecommunications Drawings apply to work of this section. The overall and detailed Public Address/ Background music system referred hereinafter as the PA system design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- C. General: Installation practices for PA system as describe herein take precedence over any other section in the construction documents set.

1.2 SCOPE OF WORK

- A. The PA System (PAS) Installer shall be responsible for the complete installation of the PA System, including but not limited to the provision, fabrication and installation of the amplifier racks, microphone switching unit, microphone stations, microphones, all speakers, speaker enclosures, baffles, the wiring of all components, interfacing to existing equipment and testing/adjusting of the complete PA System.
- B. For all raceways part of the PA system, see specification section 270528.

1.3 SYSTEM DESCRIPTIONS AND REQUIREMENTS

- A. The PA system is composed of the following components and subsystems:
 - 1. Paging stations
 - 2. Microphone audio/control distribution system
 - 3. Audio switching and control system.
 - 4. Digital Signal processing systems and components
 - 5. Power amplifiers
 - 6. Speakers
 - 7. Test and monitoring system and components
 - 8. Racks, cabinets and accessories.
- B. When the proposed system uses structured wiring infrastructure, including but not limited to premises UTP or STP cable, fiber optic cables, backbone copper cables, patch panels, telecommunications outlets, punchdown blocks; all specifications given in section 271000 shall apply to this part of the work.

1.4 INSTALLER QUALIFICATIONS

- A. General: The PAS installer selected for the Project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.
- B. General: The PAS installer directly responsible for this work shall be a "Audio Visual System Installer" who is, and who has been, regularly engaged in the providing and installation of commercial and industrial audio visual systems of this type and size for at least the immediate past five years. Any sub Installer who will assist the PAS installer in performance of this work, shall have the same training and certification as the PAS installer.
- C. Certification: The PAS installer's Project Manager shall possess a current BICSI Registered Communications Distribution Designer (RCDD®) certificate or an ICIA® Certified Technology Specialist (CTS) designation. All shop drawings submitted by the installer shall bear the RCDD's stamp or the name of the CST.
- D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and testing audio visual systems and have personnel who are adequately trained in the use of such tools and equipment. The Owner or engineer may elect to request submittal of additional financial, operational and administrative information of the installer to demonstrate the required experience.
- E. The Installer shall possess a Low Voltage License.
- F. The Installer shall maintain a permanent office within 150 miles of the project site.
- G. A current certificate of insurance meeting the Owner minimum insurance requirements.

1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Substitutions are allowed for this system as long as all substitutions do not represent and change in architecture and have exactly the same performance as the basis of design

1.6 SHOP DRAWINGS AND SUBMITTALS

- A. The PAS installer shall follow all requirements for shop drawings indicated in specification section 270010
- B. General: Submittals shall include manufactures cut sheets for all proposed equipment. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting. The followings items shall be submitted:
 - 1. All wire and cable.
 - 2. All connectors and required tooling.

3. All termination system components for each cable type.
 4. All Active and passive hardware components.
 5. All software components
 6. All grounding and surge suppression system components for the systems portion of the project.
- C. A resume of qualifications shall be submitted with the installer's bid indicating the following:
1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 2. A list of test equipment proposed for use in verifying the integrity of the installed distributive information local area network system.
 3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project.
 4. Similar documentation for any sub installer who will assist in the performance of this work.

1.7 WORK EXTERNAL TO THE BUILDING

- A. General: Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.

PART 2 - PRODUCTS

2.1 PAGING STATIONS

- A. General: The purpose of the paging stations is to initiate a page in the system. Refer to design drawings to identify the different types of paging stations.
- B. The microphone of the paging stations shall be a dynamic microphone with a cardioid (unidirectional) pickup pattern to suppress unwanted background noise. The frequency response of the microphone shall be at least from 40Hz to 10KHz. The sensitivity of the microphone at 1KHZ shall be as follow:
1. Low level: -57.5 dB (1.3 mV).
 2. High level: -38.5 dB (12 mV)
- C. The microphone mounting depends on the type of paging station. The type of microphone mounting, according to the different paging stations types are:
1. For type 1 paging stations: The microphone shall be mounted as a gooseneck, hand held transmitter. Handheld microphone, desktop base station type. Only one selection possible
 2. For type 2 paging stations: The microphone shall be mounted as a gooseneck, hand held transmitter. Handheld microphone, desktop base station type. Only one selection possible.
 3. For type 3 paging stations: The microphone shall be mounted as a gooseneck, hand held transmitter. Handheld microphone, desktop base station type. Only one selection possible.

Add any additional types that might be required.

- D. The base of the paging station could have one or more “push to talk” buttons, a 12 button keypad, an LCD display, a speaker and one or more LED indicators, depending on the type of paging station. The type of base according to the different paging stations types are
1. For type 1 paging stations: The base shall have X “push to talk” buttons, a 12 button keypad, a X line by Y character LCD display, a 4” speaker, the following LED indicators: a green (ready) and a red (busy), for a horizontal (vertical) wall mount, desktop, rack mount application. Select all that apply to this paging station type. DON’T FORGET TO CHANGE THE X FOR THE RIGHT NUMBER.
 2. For type 2 paging stations: The base shall have X “push to talk” buttons, a 12 button keypad, a X line by Y character LCD display, a 4” speaker, the following LED indicators: a green (ready) and a red (busy), for a horizontal (vertical) wall mount, desktop, rack mount application. Select all that apply to this paging station type. DON’T FORGET TO CHANGE THE X FOR THE RIGHT NUMBER.
 3. For type 3 paging stations: The base shall have X “push to talk” buttons, a 12 button keypad, a X line by Y character LCD display, a 4” speaker, the following LED indicators: a green (ready) and a red (busy), for a horizontal (vertical) wall mount, desktop, rack mount application. Select all that apply to this paging station type. DON’T FORGET TO CHANGE THE X FOR THE RIGHT NUMBER.

Add any additional types that might be required.

- E. When paging stations require a non-standard (standard meaning a gangable electrical box) backbox for the installation, the PAS installer shall provide them as part of this contract. The PAS installer shall provide as well any other accessories required for the correct operation or mounting of the page stations, including but not limited to power adapters, mounting clips, connectors, anchors, etc.
- F. The paging station shall include a built-in test oscillator that generates a signal than can be switched into the audio communication line for testing purposes. This test signal shall be switched from the paging stations by means of the keypad or from the main switching and control system. This is only required for large system like IED. Delete if not applicable.

2.2 MICROPHONE AUDIO/CONTROL DISTRIBUTION SYSTEM

- A. General: The purpose of the microphone audio/control distribution system is to transmit the audio/control and test signals from the paging stations to the audio switching and control system. This system could be composed of active or passive components, as described in the design drawings.

FOR HARDWIRED SYSTEM (NON CAT6) INCLUDE B, C AND D.

- B. Audio signals shall be distributed from the paging station to the audio switching and control systems by means of a twisted pair 100% shielded cable, made of stranded copper conductors with a AWG-22 Tinned copper drain wire. The gauge of this cable shall be selected according to the distance of the cable run, to ensure a less than 5% of signal loss. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.
- C. Control signals shall be distributed from the paging station to the audio switching and control systems by means AWG-22 twisted pair 100% shielded cable, made of stranded copper

conductors with an AWG-22 Tinned copper drain wire. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.

- D. For desktop mounted paging stations, the above mentioned cables shall be terminated in an outlet box with XLR type connectors. The paging stations shall have a flexible cord or a rubber insulated cable terminated with the corresponding mating connectors in the paging station and the outlet box.

FOR IP BASED SYSTEMS THAT USE A BRAKEOUT BOX INCLUDE B, C, D, E, F and G.

- E. The audio and control signals from the paging stations to the audio switching and control systems shall be transmitted by analog means to an Ethernet gateway, and from this gateway shall use digital means to get to the audio switching and control system.
- F. Audio signals shall be distributed from the paging station to the Ethernet gateway by means of a twisted pair 100% shielded cable, made of stranded copper conductors with a AWG-22 Tinned copper drain wire. The gauge of this cable shall be selected according to the distance of the cable run, to ensure a less than 5% of signal loss. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.
- G. Control signals shall be distributed from the paging station to the Ethernet Gateway by means AWG-22 twisted pair 100% shielded cable, made of stranded copper conductors with an AWG-22 Tinned copper drain wire. The jacket of this cable shall be rated as CMR or CMP if installed in plenum environments.
- H. For desktop mounted paging stations, the above mentioned cables shall be terminated in an outlet box with XLR type connectors. The paging stations shall have a flexible cord or a rubber insulated cable terminated with the corresponding mating connectors in the paging station and the outlet box.
- I. The Ethernet gateway shall be a multiple input device (quantity of inputs as indicated on design drawings) capable of delivering hi fidelity audio signals to the audio switching and control system by means of an Ethernet network. The specifications of the Ethernet gateway are:
 - 1. Signal types: It shall be able to upload microphone or line level analog audio signals.
 - 2. Power: It shall be capable of sending 48 VDC phantom power to the paging stations.
 - 3. Frequency response: 20 Hz – 20 KHz with a +4 dBu input signal.
 - 4. Total harmonic distortion: 0.01% @ 1KHz with a +4 dBu input signal.
 - 5. Dynamic range: 78 dBA for mic level signals, and 95 dBA for line level signals
 - 6. Input gain: software controllable from -9 dB to +60 dB, in 1 dB increments.
 - 7. A/D quantization: 24-bit resolution.
 - 8. Audio sampling: 48 KHz
 - 9. Communication protocol: Cobranet™ over 100Base T Ethernet link.
- J. The wiring of the system from the Ethernet gateway to the audio switching and control system shall be by means of UTP cable or fiber optics, according to design drawings. The PAS installer shall follow all specifications of section 271000 to do this wiring.
- K. All networking equipment required to communicate from the Ethernet gateway to the audio switching and control system, including but not limited to switches, routers, media transceivers or gateways shall be provided by the **PAS installer owner**. **IF provided by the PAS installer, please refer to specification section that addresses this equipment.**

FOR PURE IP BASED SYSTEMS OR INTERCOM BASED SYSTEMS INCLUDE B ONLY.

- L. The audio and control signals from the paging stations to the audio switching and control systems shall be transmitted by UTP or fiber optic cables as indicated in the design drawings. The PAS installer shall follow all specifications of section 271000 to do this wiring.

2.3 AUDIO SWITCHING AND CONTROL SYSTEM

- A. General: The purpose of the Audio switching and control system is to route the page announcements from the paging stations to the user selected output zones.

DESCRIPTION OF THE HEAD END EQUIPMENT MUST BE INCLUDED HERE ACCORDING TO THE SELECTED SYSTEM CONFIGURATION

2.4 DIGITAL SIGNAL PROCESSING SYSTEM AND COMPONENTS

- A. General: The purpose of the digital signal processing system is to filter, limit, or alter the original audio input on any desired way to enhance the audio response of the page announcement or background music by means of DSP active equipment.
- B. The digital system processing system shall be 100% software controllable with 4 or 8 multiple audio inputs and outputs. The control software shall be installed on a standard PC, and shall provide complete display and control in graphical form, of all signals processing configurations and functions. Once the system is programmed, the unit shall be capable of storing the configuration in non-volatile memory.
- C. The digital signal processing system shall be configurable to utilize a variety of signal processing algorithms, including but not limited to:
 - 1. Input and output gain control with meters.
 - 2. Parametric bandpass, all-pass, high and low shelf & cut filters.
 - 3. Feedback suppression.
 - 4. Graphic equalization
 - 5. Crossovers
 - 6. Compression, limiting, automatic gain control, ambient noise compensation.
 - 7. Mix, select, level control and delay.
 - 8. Pink noise and sine wave generation.
- D. The data conversion of the digital signal processing system shall be 24-bit, 48 KHz sampling rate.
- E. The unit shall meet UL/CSA and CE safety requirements.

2.5 POWER AMPLIFIERS

- A. General: The purpose of the power amplifiers is to amplify all audio signals to be transmitted to the speakers. The power amplifier shall be a 70V direct constant voltage unit with the following features:
 - 1. Power supply shall be of the switching type.

2. Rack mountable with cooling fans for front to back, or side to side ventilation.
 3. Input sensitivity independent for each channel.
 4. Unit shall have protection circuits for amplifier overheat, shorted outputs, DC, mismatch loads, under/over voltage, high frequency overloads and internal fault.
 5. Switchable high-pass filter per channel, to eliminate step down transformer saturation at low frequencies.
 6. Comprehensive indicators array for Power, Data, Read, Signal, Thermal and Fault.
 7. Unit shall be UL listed
- B. Power handing: All amplifiers shall be seized to handle 75% of the total load of the speaker's line.
- C. The audio handing performance of the power amplifiers shall be:
1. Frequency response: 20Hz to 20Khz \pm 1dB @ 75% of the rated power.
 2. Signal to Noise ratio: 105dB A-weighted below power rating from 20Hz o 20KHz.
 3. Total Harmonic Distortion (THD): <0.4% @ rated power from 20HZ to 20Khz.
 4. If unit has two or more channels. Crosstalk: >80dB, below rated power from 20Hz to 1KHz.
 5. Common mode rejection ratio (CMRR): >40 dB from 20Hz to 20KHz.
 6. Damping factor: >1000 (Use 13 for IED systems)

FOR LARGER SYSTEM:

- D. Amplifiers shall be of switching type.
- E. Amplifier shall be capable of being monitored from the test and monitoring system through an 100Mb Ethernet connection.

FOR IED SYSTEMS ADD THE FOLLOWING.

- F. Backup amplifiers shall be provided with automatic switching capabilities. System shall be supplied with one backup amplifier per seven (7) working units: The backup unit shall have a rated power equal to the unit with highest rating of all seven units.

2.6 SPEAKERS

- A. General: All speakers shall include a 70V transformer. Speakers are classified in types according to the location where they will be installed. The design drawings indicate all different types and locations in the floor plan.
- B. SPEAKER TYPE 10: This speaker type shall be used for ceiling lower than 10 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 10 shall have the following specifications:
1. Speaker: 4" coaxial loudspeaker with a 25W power rating
 2. Woofer construction: Poly cone butyl rubber.
 3. HF driver construction: PEI dome tweeter.
 4. Frequency response: 75Hz to 20Khz
 5. Sensitivity: 88 dB average.
 6. Magnet weight: minimum of 10 oz.
 7. Voice coil diameter: 1 inch

8. Transformer tabs: 1,2,4,8 and 16 W.
 9. Enclosure: acoustically treated, front loading with a minimum depth of 7". Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
 10. Grill: shape, finish and color shall be coordinated with the architect.
 11. Basis of design: Atlas soundolier model FAP42T
- C. SPEAKER TYPE 11: This speaker type shall be used for ceilings between 16 ft. and 10 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 11 shall have the following specifications:
1. Speaker: 6" coaxial loudspeaker with a 50W power rating
 2. Woofer construction: Poly cone butyl rubber.
 3. HF driver construction: PEI dome tweeter.
 4. Frequency response: 63Hz to 20Khz
 5. Sensitivity: 88 dB average.
 6. Magnet weight: minimum of 14 oz.
 7. Voice coil diameter: 1 inch
 8. Transformer tabs: 2,4,8,16 and 32 W.
 9. Enclosure: acoustically treated, front loading with a minimum depth of 7". Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
 10. Grill: shape, finish and color shall be coordinated with the architect.
 11. Basis of design: Atlas soundolier model FAP62T
- D. SPEAKER TYPE 12: This speaker type shall be used for ceilings between 25 ft. and 16 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 12 shall have the following specifications:
1. Speaker: 8" coaxial loudspeaker with a 70W power rating
 2. Woofer construction: Polypropylene cone & SBR surround.
 3. HF driver construction: PEI dome tweeter.
 4. Frequency response: 55Hz to 20Khz
 5. Sensitivity: 90 dB average.
 6. Magnet weight: minimum of 21 oz.
 7. Voice coil diameter: 1 inch
 8. Transformer tabs: 1.9, 3.8, 7.5, 15, 30 and 60 W.
 9. Enclosure: acoustically treated, front loading with a minimum depth of 7". Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
 10. Grill: shape, finish and color shall be coordinated with the architect.
 11. Basis of design: Atlas soundolier model FAP82T
- E. SPEAKER TYPE 13: This speaker type shall be used for ceilings between 50 ft. and 25 ft. high. This speaker could be mounted in dry-wall or lay-in ceiling applications. Speaker type 13 shall have the following specifications:
1. Speaker: 12" coaxial loudspeaker with a 250W power rating
 2. LF driver construction: 12" diaphragm.
 3. HF driver construction: 2.5" diaphragm with 20 oz magnet.
 4. Frequency response: 33Hz to 21Khz
 5. Sensitivity: 117 dB average.
 6. Magnet weight: minimum of 70 oz.
 7. Voice coil diameter: 2.5 inch

8. Transformer tabs: 7.5,15,30 and 60 W.
9. Enclosure: acoustically treated, front loading with a minimum depth of 15".Unit shall have conduit knockouts, and shall include all mounting accessories like plaster rings, trim rings, and tile bridge.
10. Grill: shape, finish and color shall be coordinated with the architect.
11. Basis of design: Atlas soundolier model 12CXT60 with Q4812 enclosure

F. SPEAKER TYPE 20: This speaker type shall be used for wall mount applications in small rooms. Speaker type 20 shall have the following specifications:

1. Woofer Speaker: 5.25" polypropylene cone with rubber surround and 20 oz. magnet
2. Tweeter speaker: 1" Mylar diaphragm with a 1.39 oz. magnet.
3. Frequency response: 85Hz to 20Khz
4. Sensitivity: 90 dB average.
5. Transformer tabs: 0.94, 1.9, 3.7, 7.5, 15 and 30 W.
6. Accessories: mounting bracket included.
7. Color: black or white, selection by architect.
8. Basis of design: Atlas soundolier model SM52T

G. SPEAKER TYPE 21: This speaker type shall be used for wall mount applications in large rooms. Speaker type 21 shall have the following specifications:

1. Woofer Speaker: 8" hycone treated paper cone with treated cloth surround and 30 oz. magnet
2. Tweeter speaker: 1" titanium diaphragm with a 13 oz. magnet.
3. Frequency response: 65Hz to 20Khz
4. Sensitivity: 92 dB average.
5. Transformer tabs: 1.9, 3.8, 7.5, 15, 30 and 60 W.
6. Accessories: mounting bracket included.
7. Color: black or white, selection by architect.
8. Basis of design: Atlas soundolier model SM82T.

2.7 TEST AND MONITORING SYSTEM AND COMPONENTS

- A. General: The purpose of the test and monitoring system is to allow the system's user to test and troubleshoot the PA system.
- B. The test and monitoring system shall be capable of monitoring and testing the following subsystems of the PA system:
 1. Paging stations (Only in IED systems)
 2. The microphone audio/control distribution system (Only for IP based systems)
 3. The audio switching and control system.
 4. The digital signal processing system.
 5. The Power amplifiers
 6. The speaker lines coming out of the amplifier.
- C. The paging stations shall be capable on creating an audio tone that will be tested throughout the complete PA system line to check all components. The tone shall be triggered by the test and monitoring system automatically and the time and dates for those events shall be programmable. (For IED systems)

- D. The PA system shall have a paging station and a rack mounted speaker at the headend location for troubleshooting purposes. From this page stations it shall be possible to do local pages in each system zone as well as any other type of general pages that are available in other stations in the system.
- E. The audio hubs in the microphone audio/control distribution system shall be capable of testing through the IP network by means of a ping command. The units shall also have indicators built-in to display the strength of the audio signal coming in or out of the unit. (For IP based system)
- F. The audio switching and control system as well as the digital signal processing system, and the power amplifiers shall be monitored through software.
- G. The power amplifiers shall report alarms like power supply temperature, thermal level meters, fault reports and speaker line shorted or open reports.
- H. The monitoring station shall be rack mountable and shall display all systems alarms in an event log window.

2.8 RACKS, CABINETS AND ACCESSORIES

- A. General Description:
 - 1. The installer shall supply a system of vertical racks capable of supporting specified electronics.
 - 2. The cabinets shall be comprised of interchangeable modular components capable of being configured in a variety of heights either as a single unit or as a series of connected units.
 - 3. Side components shall offer ventilation. The bottom shall be open with closure panel available.
 - 4. Rack rail options shall include both punched and tapped (threaded) holes.
 - 5. Model options shall include those that are welded and shipped as an assembled unit or those that are shipped knocked down and assembled on site
- B. Standards:
 - 1. The system shall preferably comply with Underwriters Laboratories (U.L.) listing. Copy of the U.L. certificate of approval to be submitted upon request.
 - 2. The system shall comply with Electronic Industry Association (E.I.A.) specifications for rack mounting ANSI/EIA standard RS-310.
- C. Modular pre-engineering construction:
 - 1. All components within each rack cabinet shall be:
 - 2. Of pre-engineered construction i.e: constructed from a series of independent components.
 - 3. Available from a pre-defined set of manufacturer's component model numbers or as a single model number representing a complete cabinet.
 - 4. In common production for at least two years prior to the date of submission.
 - 5. Free from alterations to the installed cabinet or series of cabinets, will be accomplished without the need for either welding or carpentry work.
 - 6. Capable of cables or conduits passing through the entire width of a series of connected vertical cabinets without obstruction.
 - 7. Capable of supporting E.I.A. standard 19"(483mm) width rack mounted equipment.

8. Constructed of 14 and 18 gauge (.074" and .047") steel superstructure framework with external attachable side, top, rear, and bottom panels 20 gauge (.036") sides, 14 gauge (.074") base, 20 gauge (.036") tops, and 14/18 gauge (.074"/.047") combo for frames.
9. Constructed of 14 gauge (.074) steel inner and outer rack rails.
10. Supplied with a series of standard vented or solid blank panels which are determined by the installer and included to cover areas not filled in with specified equipment. These panels shall be measured in standard rack unit multiples and available with standard part numbers for future changes to the system.

D. Optional accessories and mounting hardware:

1. A full range of optional accessories are available including but not limited to: Caster kit, electrical outlet supply, anti-tip extension legs, shelf support brackets, stationary shelves, pullout shelves, rack slide kits, drawers, blowers and cooling fans, corner fillers and spacers.
2. Mounting hardware for the specified electronics shall be available upon request. Panel bolts, washers and clips with captive nuts suitable for use with E.I.A. standard punched racks shall be included.
3. Slide kits where appropriate (including drawers) shall be of ball bearing operation. Friction or roller type slides are not acceptable.

E. Uninterrupted power supply:

1. All racks shall include a UPS unit cable of handling the power requirements of that specific rack where they are installed.
2. The UPS shall have remote monitoring capabilities through and Ethernet connection.

2.9 BASIS OF DESIGN

- A. The Project Documents have been developed, in conjunction with the Owner, to establish a benchmark level of performance and reliability. The basis of design for the PA system is the **XXX** solution. Acceptable alternate product manufacturers are **XXX** and **XXX**. Deviations from the basis of design (including deviations for manufacturers stated herein as "acceptable" alternates) must be in accordance with the substitution requirements of Section 270010. Use of an alternate product, whether or not it is stated as "acceptable" herein, does not relieve the Installer of their responsibility to comply fully with the entirety of the Project Documents.

2.10 IDENTIFICATION AND LABELING TAGS

- A. The PAS installer shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 INSTALLATION PRACTICES

- A. The PAS installer shall follow all installation practices indicated in specification section 270010.

- B. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.
- C. All wiring terminals, connectors, punch down blocks shall be clearly labeled and numbered. These designators shall be shown on the "as built" drawings. The labeling process shall be consistent with any owner standard or if non-existing, it shall comply with ANSI/TIA/EIA-606 C "Administration Standard for Telecommunications Infrastructure of Commercial Buildings".
- D. All major components installed in the equipment racks shall be equipped with engraved or photo laminated labels identifying area(s) served by that device. The labels shall correspond with designators on the "as built" drawings.
- E. Physical integrity of cables shall pass not only electronic testing but visual inspection as well by the Owner and/or the Engineer.
- F. Only a single point of ground, located at the amplifier cabinets shall be used.
- G. All wiring shall be separated as far as practical relative to signal levels (microphone level, speaker level and AC power). None of these different groups of cables may share a common raceway or wiring trough.
- H. All speaker lines shall be terminated in screw type terminal blocks located on DIM rails inside the equipment cabinets. All microphone cables shall be terminated on rack mounted 110 punchdown blocks, at least four (4) feet away from speaker line terminations.
- I. All connections to screw type terminals shall be made only by spade lugs, crimp fastened to wire.
- J. Splices within conduit runs, or cable trays shall not be permitted.
- K. Amplifier cabinets shall be properly grounded.
- L. All active equipment for the PA system shall be protected by power surge suppressors and backed up with UPS power.

3.2 PA SYSTEM INSTALLATION

- A. The Installer shall install and wire all speaker enclosures, speakers, baffles and microphone stations as shown on the drawings. Speaker enclosures shall be stuffed with 5/16" thick sound deadening acoustic batting with a density of 2 lb/cu. ft, and features an acoustic fiber board bottom to prevent "oil canning". For 12" speakers the enclosure shall have a 1.5" fiberglass liner.
- B. All ceiling mounted speakers shall be installed with a safety support to a solid building structure.
- C. All ceiling mounted speakers shall be provided with the corresponding supports to mount in dry wall ceiling or acoustical tile ceilings.
- D. The PAS installer shall make provisions for adding supports to the speaker's backboxes in case the ceiling structure can't support the weight of the speaker/backbox assembly.

- E. All output zones shall be included in the digital signal processing systems. The PAS installer shall program this system until the owner is satisfied with the sound output. All programming tools and software shall be delivered to the owner as part of the hand-over process. The final system configuration of the digital system processing system shall be documented and delivered to the owner as part of the as-built documentation.
- F. The Installer shall fabricate and install the amplifier racks, including all components. Spare equipment shall be installed in racks as shown on the drawings.

3.3 SERVICE SLACK

- A. All PA system cable runs shall not contain service slack prior to the termination point at the head-end equipment side. Service slack at PA rooms shall consist of a 10 foot slack section located and placed neatly in the cable ladder above the equipment rack in an extended large diameter loops or in a loose figure 8 configurations.

3.4 CONDUIT INSTALLATION AND WIRING

- A. Minimum conduit size shall be 3/4 inch, except the small section of flex conduit linking the speaker enclosure to the ceiling mounted J-box above the speaker. This short section of flex conduit can be sized 1/2".
- B. All speaker and microphone wiring shall be run in conduit. Size of the conduit shall be in compliance to National Electrical Code (NEC) and local codes fill ratios.
- C. PA system installer shall provide all conduit, wiring and supports materials required by the system.
- D. Conduits shall be installed by the Installer for all "home run" wiring and at all areas.
- E. Minimum conduit size shall be 3/4 inch, except the small section of flex conduit linking the speaker enclosure to the ceiling mounted J-box above the speaker. This short section of flex conduit can be sized 1/2".
- F. All speaker and microphone wiring shall be run in conduit. Size of the conduit shall be in compliance to National Electrical Code (NEC) and local codes fill ratios.
- G. All conduit runs shall follow specifications in section 270528.
- H. The Installer shall install all cable trays and wiring as required for the installation of the audio racks.
- I. All speaker wires shall have an overall shield and the wire size shall guarantee a maximum of two 2% voltage drops to the farthest speaker in a zone. Minimum wire size shall be AWG-18 in all cases.
- J. All microphone audio and control lines wire shielding and sizing shall be in accordance to system vendor recommendations and standard distance limitations.

- K. All PA system cabling using UTP cable or fiber optics cables shall comply with section 271000 specifications for all requirements.

3.5 REQUEST OF IP ADDRESS

- A. General: The PAS installer shall follow all requirements indicated in specification section 270010 for the request of IP addresses for devices part of the PAS.

3.6 SYSTEMS WARRANTY AND SERVICE

- A. General: The PAS installer shall follow all warranty and service requirements indicated in specification section 270010.

3.7 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The PAS installer shall follow all test requirements indicated in specification section 270010
- B. As part of the Engineer's final acceptance the following activities will be executed by the Engineer:
 - 1. Test all microphones in the system and all their features
 - 2. Test for audio at all speakers with a SPL meter
 - 3. Any other test the engineer deems necessary to establish the system is operating properly.

3.8 TEST EQUIPMENT REQUIRED

- A. Sound pressure level meter with the following characteristics:
 - 1. Applicable Standards: IEC 61672-1, 60651 and 60804 Type 2, ANSI S1.4 Type 2
 - 2. Accuracy: $\pm 1.5\text{dB}$ (ref 94dB@1KHz)
 - 3. Resolution: 0.1dB
 - 4. Digital Display: 4 digital LCD
 - 5. Measurement Parameters: SPL, SPL MIN/MAX, SEL, and Leq
 - 6. Measurement Range: 30dB to 130dB
 - 7. Linearity Range: 100dB
 - 8. Measurement Frequency Range: 31.5Hz to 8KHz
 - 9. Frequency Weighting: A and C
 - 10. Response Impulse: Fast and Slow
 - 11. Microphone: 1/2 " Electret condenser microphone
 - 12. Sampling time: updated every 0.5s
 - 13. Bar graph: 4dB steps, 100dB range, 125ms update
- B. A pink noise audio source to be played in the system to check SPL.

3.9 TRAINING AND INSTRUCTION

- A. General: The PAS installer shall follow all training requirements indicated in specification section 270010.

- B. The PAS installer shall provide for Factory training for all hardware and/or software components. The installer shall provide for a week of training for three employees at the Manufacturer's facilities. The scope of the training shall include design, operation and maintenance of the system installed. The detailed schedule of the training shall be submitted by the installer no later than 10 days after a contract is signed.
- C. The training for this system shall include:
 - 1. User system operation training: Three sessions of two to three hours each, of user system operation on site to a maximum of fifteen attendants per session. Each session shall cover the same topics. One set per attendant of basic user operation material shall be delivered by the PAS installer.
 - 2. System administration training: Three sessions of at least four hours of system administration training on site to a maximum of five attendants per session. One set per attendant of System Administration material shall be delivered by the PAS installer.

3.10 SPARE PARTS AND TOOLS

- A. Prior to completion of this project the PAS installer shall provide spare parts for this system as referenced below. All spare parts provided for this project must be new hardware. Factory serviced or reconditions components shall not be acceptable. All equipment must be made available for inspection prior to delivery. Provide an inventory record of all spare parts to avoid any discrepancies. The delivery date shall be coordinated with the owner to ensure that secure storage of these parts can be provided upon receipt. The spare parts to be provided are:
 - 1. Paging stations: complete quantity of each type.
 - 2. Speakers: complete quantity of each type.
 - 3. List all other equipment.

3.11 AS-BUILT DOCUMENTATION AND CLOSE OUT INFORMATION

- A. General: The PAS installer shall follow all as built and close out information requirements indicated in specification section 270010
- B. As-built documentation shall include:
 - 1. Floor plans with all speakers, microphones, conduits and boxes shown and numbered as installed.
 - 2. All cable routings (trunk lines) and elevations of each TR or ER indicating outlet, tie, and riser cable terminations shall be required.
 - 3. All addendum information or project revisions resulting in drawing changes that occur during the construction period shall be documented and included in the as-built material.
 - 4. All rack elevations and mounting details.
 - 5. The PAS Installer shall provide a spreadsheet with the following information:
 - a. For speakers: speaker model, speaker number, zone, location and transformer tab used.
 - b. For microphones and sense microphones: microphone model, microphone number, zone, location and marking of the cables that the microphone uses.
- C. The close out information shall also include:
 - 1. Submission and Approval of test reports.

END OF SECTION 275113

SECTION 281000 ELECTRONIC SECURITY SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The scope of work shall include furnishing all labor, materials, enclosures, wiring, equipment, programming, training, testing, documentation and warranty support, required to provide a completely operational and working Security System.
- B. The Security System Installer (SSI) shall coordinate with the door frame installer, the door installer, the door hardware installer and gate installers on the placement of all electronic locking hardware and door controls for this project. The SSI shall provide the low voltage power supplies for all electric locks, wire and cable, terminate all connections, and shall interface this equipment with the integrated security system.
- C. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher) components required for the security system shall be in compliance with specification Section 271000.
- D. The scope of work for this specifications also include the following items:
 - 1. The programming of the access control software including the integration described in this specification section.

1.2 RELATED DOCUMENTS

- A. General Terms and Conditions of the Contract Documents
 - 1. Division 8 – Door Hardware
 - 2. Division 26 – Electrical
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 282000 Video Surveillance System

1.3 SECURITY SYSTEM INSTALLER QUALIFICATIONS

- A. The SSI selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. The SSI must have a minimum of 5 qualified and factory trained technicians to support this system. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years. This company shall have a fully staffed office of sales and technical support representatives within 100 miles of travel to this project.

- B. Other required SSI qualifications are:
 - 1. The SSI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The SSI shall be able to perform any and all repairs to the system within 24 hours.
 - 2. The SSI, as a minimum, must carry a current state issued limited energy license.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 270010.
- B. Due to compatibility issues with other buildings under the control of the owner, the only approved system to be provided in this project is XXXXXXXXXXXXXXXX. No substitutions are accepted for this type of equipment.
- C. Sensors or door security devices with the exception of card readers shall allow for substitutions.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The SSI shall follow all requirements for shop drawings indicated in specification section 270010.
- B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.
 - 1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
 - 2. Product numbers, specifications, and data sheets for all equipment.
 - 3. Data sheets and samples of all labeling materials and equipment to be used in the project.
 - 4. A complete explanation of the identification method to be used for all equipment and cabling part of the security system.
 - 5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
 - 6. Detailed drawings of all custom products to be used in the project.
 - 7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.
- C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
 - 1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. Access controlled doors shall have the door name. All other devices shall have a unique identifier, as they will be programmed in the system.
 - 2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each door type and for each type of device in the system.

3. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all access control panels, alarm panels, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
4. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
5. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
6. Termination details for multi-conductor connectors and other details not included in item 2 of the shop drawings.
7. Outline of the testing process.
8. Training syllabus for all systems included in this scope.

1.6 ABBREVIATIONS

- A. Additional abbreviations used in this document:
 1. ADA - Americans with Disabilities Act
 2. API - Application Programming Interface
 3. ASCII - American Standard Code for Information Interchange
 4. BPS - Bits Per Second
 5. DIN - German Institute of Standardization
 6. DPS - Door Position Switch
 7. FCC - Federal Communications Commission
 8. GUI - Graphical User Interface
 9. ID - Identification
 10. I/O - Input /Output
 11. ISC: Intelligent System Controller
 12. ODBC - Open Database Connectivity
 13. O&M - Operations and Maintenance
 14. PIN - Personal Identification Number
 15. PTZ - Pan/Tilt/Zoom
 16. RAID - Redundant Array of Independent Disks
 17. REX - Request to Exit
 18. RoHS - Restriction of Hazardous Substances Directive
 19. SCS - Security Control System
 20. SDRAM - Synchronized Dynamic Random Access Memory
 21. STP - Shielded Twisted Pair
 22. UL - Underwriters Laboratories, Inc.
 23. UPS - Uninterrupted Power Supply
 24. USB - Universal Serial Bus
 25. UTP - Unshielded Twisted Pair
 26. VOC - Volatile Organic Compounds

1.7 GLOSSARY OF TERMS

- A. The following terms are defined for the purposes of this specification:

1. Access Group: A logical group of card readers (terminals) which may be connected to one or more sub-controllers and which represent a collection of readers for which a particular cardholder may have access privileges.
2. Access Mode: The mode of operation in which the security control system shall only annunciate tamper and trouble conditions at a monitored point. Alarm conditions shall not be annunciated in this mode. Also referred to as alarm shunting.
3. Acknowledge: The action taken by a security control system operator to indicate that he/she is aware of a specific alarm or tamper state.
4. Action Messages: A set of instructions automatically provided to the operator when an alarm condition is generated.
5. Advisory: A message provided by the security control system to the operator to inform him/her of a condition as reported by the security control system.
6. Alarm Condition: A change of state, as sensed by the security control system, indicating that the security control system has detected a condition which its sensors were designed to detect.
7. API Integration: a method to transfer information between two systems by means of APIs, though an Ethernet communication network.
8. Cardholder: A person who has been issued a valid access card.
9. Card Reader: A device usually located at access points, designed to decode the information contained on or within a card key credential for the purposes of making an access decision or for identity verification.
10. Clear: The action taken by a security control system operator to respond to an alarm condition or advisory so that other alarms may be serviced or so that other actions may be taken.
11. Download: To send computer data from the File Server to a controller for the purposes of making access decision without the intervention of the File Server.
12. Facility Code: A coded number, in addition to the individual card number, stored within each card key that uniquely identifies the facility at which the card is valid. This feature prevents cards from one facility from being used at another facility that has a similar access control system.
13. File Server: Primary host computer in the networked security system which maintains the access control system database.
14. Line Supervision: The monitoring of an electrical circuit via electrical and software systems to verify the electrical integrity of the supervised circuit.
15. Off-line: A condition in which a controller(s) is not in communication with the File Server. In the off-line mode, the controller continues to make access decisions and process alarms according to the information stored at its local database.
16. Password: A combination of numbers or letters unique to security control system operator which defines commands and data fields he/she may view, edit, or command.
17. Relay integration: A method to transfer signals between two systems by means of using potential free contact closures to input points.
18. Reset: A command or feedback signal that indicates that a monitored point has returned to its normal state after having transferred to the alarm or trouble state.
19. Secure Mode: The normal state of an alarm input point from which it will be monitored for change of state to either an alarm or trouble condition.
20. Secured Area: A physical location within the facility to which access is controlled by one or more card readers.
21. Secured side: Side of a security door where a higher security level needs to be granted for a user to be authorized to be in that side of the door.
22. Serial line integration: A method to transfer information between two systems by means of an RS-232/RS-422 or RS-485 line, using ASCII strings.

23. Tamper: A condition within the circuitry of a monitored point which indicates the electrical integrity of that sensing circuit has been compromised.
24. Tamper proof screws: A screw with a security hexalobular internal driving feature as described in ISO 10664. As an example, a security TORX head, as developed by Camcar LLC.
25. Time Interval: A time stamp of one start time and one stop time within a time period.
26. Time Period: A user programmable period of time made up of days of the week and hours in the day.
27. Trouble: A condition within the circuitry of a monitored point which indicates that an equipment malfunction, single break, single fault or a wire-to-wire short exists.
28. Unsecured side: Side of a security door where a lower security level needs to be granted for a user to be authorized to be in that side of the door.
29. User Definable: An attribute of a security control system function that may be easily tailored by the System Administrator.
30. Workstation: A personal computer connected to the main security control system File Server via a local area network connection for the purpose of programming the system and responding to alarms.

1.8 SYSTEM DESCRIPTION

- A. The security systems primary purposes shall be to provide access control and alarm monitoring capabilities for this project. The system shall provide functionality such as the ability to regulate and control access through specific areas of the facility and fully integrate with other security components such as closed circuit television, alarm system, intercom and digital video recording.
- B. The system must utilize a single seamlessly integrated relational database for all functionality. This integration shall be provided using a single operating environment. The operating environment shall be the fully multi-tasking multi-threading operating System.
- C. Alarm monitoring and administrative workstations must be able to connect to, and monitor, field hardware devices such as card readers and intelligent system controllers. Administrative tasks including defining asset information, access groups, time zones, configuring digital video devices, generating reports, creating maps, etc. shall be provided from any client workstation on the network that is licensed to do so. All systems must utilize a single database on the network and must be accessible in real time to any security workstation connected to the network. This shall allow for automatic change propagation to all client workstations as well as common database consolidation.
- D. A real-time graphical map representing the layout of this building shall indicate if an electronically controlled door is in a secure or unsecured mode. Control modules will be required to lock, or unlock, any electronically controlled door or vehicle gate at this facility. An automatic cardholder call-up feature shall allow for the quick search and display of images in the database. A System's Operator journal shall be available to log important daily events. A trace function shall be available for System Operator's to locate and track activity on a specific cardholder or at a specific card reader. All system hardware must be controllable using a mouse to click on the associated system icon.
- E. The security system shall be designed to support an advanced distributed network architecture, whereas Intelligent System Controllers do not need to be home-run wired back to the database

server. All Intelligent System Controllers shall be connected to an Ethernet network via industry standard TCP/IP communication protocol. Network based Intelligent System Controllers shall be able to communicate back with the database server through industry standard network switches and routers.

- F. The security system shall support a data encryption utility. In utilizing encryption technologies, data communication shall be protected between workgroups, local area network computers, domain clients and servers, branch sites which may be physically remote, extranets, roving clients, and remote administration of computers.

PART 2 - SYSTEM CHARACTERISTICS

2.1 SECURITY SYSTEM SOFTWARE

- A. The SSI shall provide all software and firmware required to upgrade servers and controllers for the complete operation of the access control system.
- B. Acceptable products for the security system software are:
 - 1. DSX
- C. Other access control system software will not be evaluated.
- D. At a minimum the security system software shall provide the following key features:
 - 1. Ability to integrate with other system with features as indicated in this specification.
 - 2. Be able to operate with cards with multiple system codes.
 - 3. Have an integrated platform with the video system.
 - 4. Support browser based clients and standard client workstation.

2.2 COMPUTER SYSTEM HARDWARE

- A. Computer based system are required for the operation of the security system. The following types of computer systems are required for the system:
 - 1. Server: System that communicates with ISC and other hardware. It is also the system with the database of all the components and transactions of the system. Server shall be installed in a secured room.
 - 2. Workstation: System accessible to users for operating, configuring and accessing reports from the security system. Workstations communicate with the server through TCP/IP.
 - 3. Badging workstation: A system used to create the picture IDs for the system
- B. INTEGRATED SERVER. When the manufacturer of the Security System Software offers the server as an integrated appliance and as a single part number, the server shall be as indicated by the manufacturer.
- C. SOFTWARE ONLY. When the manufacturer of the Security System Software offers the possibility of providing the software only and the SSI is required to provide the hardware platform for the server the SSI shall provide a server in compliance with the Minimum Specifications by Software Manufacturer (MSSM) plus an extra capacity as indicated below:
 - 1. Processor speed: MSSM + 30%

2. Cache memory: MSSM + 30%
3. Front side bus speed: MSSM +30%
4. Memory: MSSM + 100% (or maximum memory supported by Operating system)
5. Hard drive capacity: MSSM + 100% in RAID 1 configuration
6. CD/DVD Drive: DVD ROM Drive SATA, internal
7. Network Card: Dual 1 GB connections
8. Power supply: High Output Power Supply, Redundant.
9. USB ports: Minimum six (6) USB 2.0
10. Mounting: Rack chassis with sliding rapid/versa rails and cable management arm.
11. Operating system: As required by security system software.
12. Additional software: Database packages as required by Security System manufacturer. Antivirus and Internet Security package with a 1 year license
13. Warranty: 3 –year warranty.

D. BROWSER BASED WORKSTATIONS. When the manufacturer of the security system offers browser based access to the security system, workstations will be provided by owner. Browser based workstations are only allowed in the system if they provide a complete functionality of the system. If the browser based workstation offers only a partial set of functions compared to a Client based workstations, browser based workstations will only be allowed additional to client based workstations.

E. DISASTER RECOVERY SERVER When the manufacturer of the Security System Software offers the possibility of providing a load-balancing or backup solution and the SSI is required to provide the hardware platform for the backup solution, the SSI shall provide a manufacture-recommended disaster recovery server (DR) or a server in compliance with the Minimum Specifications by Software Manufacturer (MSSM) plus an extra capacity as indicated below:

1. Processor speed: MSSM + 30%
2. Cache memory: MSSM + 30%
3. Front side bus speed: MSSM +30%
4. Memory: MSSM + 100% (or maximum memory supported by Operating system)
5. Hard drive capacity: MSSM + 100% in RAID 1 configuration
6. CD/DVD Drive: DVD ROM Drive SATA, internal
7. Network Card: Dual 1 GB connections
8. Power supply: High Output Power Supply, Redundant.
9. USB ports: Minimum six (6) USB 2.0
10. Mounting: Rack chassis with sliding rapid/versa rails and cable management arm.
11. Operating system: As required by security system software.
12. Additional software: Database packages as required by Security System manufacturer. Antivirus and Internet Security package with a 1 year license
13. Warranty: 3 –year warranty.

F.

G. CLIENT BASED WORKSTATIONS. When the manufacturer of the security system requires a software client to be installed in a workstation for the management of the system and the SSI is required to provide the hardware platform for the workstation, the SSI shall provide workstations in compliance with the Minimum Specifications by Software Manufacturer (MSSM) plus an extra capacity as indicated below:

1. Processor speed: MSSM + 30%
2. Cache memory: MSSM + 30%

3. Front side bus speed: MSSM +30%
4. Memory: MSSM + 100% (or maximum memory supported by Operating system)
5. Hard drive capacity: MSSM + 100%
6. CD/DVD Drive: DVD ROM Drive SATA, internal
7. Network Card: Single 1 GB connections
8. Power supply: High Output Power Supply
9. USB ports: Minimum six (6) USB 2.0
10. Mounting: Desk mounted. If rack mounted is required a rack shelf shall be provided to mount the workstation
11. Operating system: As required by security system software
12. Additional software: Antivirus and Internet Security package with a 1 year license
13. Warranty: 3 –year warranty.

H. DESKTOP MONITORS: All workstations shall be provided with monitors. These monitors shall have the following specifications:

1. Size: 19” diagonal viewing size dimensions.
2. Display type: LED
3. Stand: 100 mm X 100 mm VESA mount adjustable height stand
4. Display aspect ratio: 16:9
5. Dot pitch: 0.248 mm
6. Max resolution: 1920X1080 /60 Hz
7. Color Support: 24 bit
8. Response time: 5 ms
9. Image Brightness: 250 cd/m2
10. Image Contract ratio: 1000:1
11. Signal input: DVI-D and VGA
12. USB ports: Two (2) USB 2.0
13. Speaker: Monitor shall be capable of mounting speakers in the bottom of the unit or in the side. Desk mounted speakers are not acceptable
14. Energy Star compliant: yes.
15. Power supply: 120 VAC

I. RACK MOUNTED MONITORS: All monitors located in rack cabinets or consoles with rack rails for workstations or servers, shall have a VESA mounting bracket and a 19” rack mount adaptor. The adaptor shall allow the monitor to mount flush to the console or cabinet. If the monitor does not mount flush, then additional rack blank plates shall be provided to cover any exposed openings. Technical specs for desktop mounted monitors shall be followed.

J. WALL OR CEILING MOUNTED MONITORS. When monitors are required to be installed in a wall or pending from ceiling in an area remote from the workstation, the following specifications shall be followed:

1. General: The monitors shall have the following specifications:
 - a. Flat panel display format: 16:9.
 - b. Flat panel technology: LED
 - c. Screen size diagonal: As indicated in design drawings \pm 1 inch.
 - d. Bezel: Bezel around screen shall be no bigger than 0.75”
 - e. Brightness (cd/m2): 500
 - f. Native resolution: 1920 X 1080
 - g. Contrast ratio: 8000:1
 - h. Refresh rate: 120 Hz.
 - i. Video input ports: (2) HDMI, (1) RGBHV.

- j. Control ports: RS-232 in a DB9 connector.
 - k. Warranty: Commercial grade unit with 3 years
 - 2. Accessories: Mounts shall be provided with all displays. Design selection for the flat panel mount is Chief Manufacturing Company recommended mount for the display specified and the type of mounting selected in the design.
 - 3. Transceivers: When the monitor is to be located more than 15 feet from the workstation, the SSI shall provide a pair of video transceiver systems using 4-pair UTP cable or fiber optics to send the signal to the monitor. The transceiver shall be selected as to properly operate at the designated distance from the workstation.
 - 4. Accepted manufacturers: Mitsubishi, LG Electronics, Panasonic, NEC, Samsung, Sharp, Sony.
- K. REPORT PRINTER. The SSI shall provide report printers as indicated in the design drawings. The report printer shall be a color laser printer. The laser printer shall be capable of printing 17 ppm in color mode in paper formats up to 8.5"X14". The laser printer shall be provided with a network interface 10/100Base-T.
- L. KVM SLIDE TRAY. The KVM slide tray shall include a rack mounted monitor, keyboard and KVM switch. The unit shall have the following specifications:
- 1. 1U Rack mount chassis
 - 2. 17" 1280X1024 TFT LCD panel
 - 3. On-screen controls
 - 4. Built-in keyboard and launch-pad mouse
 - 5. 8-port KVM switch (PS/2 or USB ports) with DVI-I inputs
 - 6. The unit shall be provided with all KVM cables with the correct mating connectors for all devices connected to the KVM switch.
 - 7. Design selection: Broadax Communication, Trip-lite, Avocent, etc.
- M. SYSTEM UPS. All workstation and servers shall receive a UPS system with an integrated surge protector. The UPS system shall be rated at 1500 VA. Minimum runtimes in the event of total power loss shall not be less than 30 minutes at full load.
- N. BADGE PRINTER: All photo identification workstations in the project shall include one badge printer. The badge printer shall have the following specifications:
- 1. Printer type: Color dye sublimation or monochrome thermal transfer printing
 - 2. Printer speed: 225 card per hour, full color single sides.
 - 3. Resolution: 300 dpi
 - 4. Card type: PVC, PVC composite, adhesive backed
 - 5. Card width/length: CR-80, CR-79, ID-1 Format, ISO7810
 - 6. Card thickness: 10 mil. To 40 mil.
 - 7. Card feeder capacity: 100 cards (30 mil)
 - 8. Communications interface: Built-in 10/100Base-T.
 - 9. Accessories to be provided: Smart-card encoder-ISO 7816, ribbons and cleaning supplies to make 3,000 cards.
 - 10. Design selection: Zebra ZC350 or similar, with proven drivers to interface with access control software system.
- O. PHOTO ID CAMERA AND LIGHTING KIT. All photo identification workstations in the project shall include one photo-id camera and one lighting kit. The specifications of the photo-id camera are:
- 1. CCD Sensor: 1/4" Sony interline CCD

2. Active pixels: 1080P
3. Sensitivity: 1 lux @ 30 IRE
4. Signal to noise ratio: > 48 dB
5. Gain: automatic or manual
6. Lens: F1.4 to 2.8
7. Zoom: Optical to 16X, Digital 128X
8. Video output: USB 2.0
9. Video capture: 15 fps @ maximum resolution.
10. Accessories to be provided: synchronized cool white lights, telescoping stand, USB cable, and universal power supply and device drivers.

2.3 INTELLIGENT SYSTEM CONTROLLER (ISC)

- A. An Intelligent System Controller (ISC) shall link the security software to all other field hardware components like card readers, inputs and outputs. Controllers shall operate as autonomous, microprocessor based processing units:
 1. ISCs shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
 2. ISCs shall be part of a fully distributed processing-control network.
 3. The portion of the database associated with a ISC, and consisting of parameters, constraints, and the latest value or status of points connected to that ISC, shall be maintained in the ISC.
- B. ISC can be one single hardware board or multiple hardware boards linked together. The following functions shall be fully implemented and operational within each ISC:
 1. Monitoring inputs (open, closed or fault).
 2. Controlling outputs.
 3. Automatically reporting alarms to the system server.
 4. Reporting of sensor and output status to the system server on request.
 5. Maintaining real time, automatically updated by the system server at least once a day.
 6. Communicating with the system server through a secured encrypted Ethernet TCP/IP communication.
 7. Communicating with other ISC or hardware devices through serial RS-422/RS-232/RS-45 encrypted lines.
 8. Executing ISC resident programs.
 9. Diagnosing.
 10. Downloading and uploading data to and from the system server.
- C. ISC Operations at a Location:
 1. Globally operating I/O linking and anti-passback functions between ISCs within the same Location without system server or workstation intervention. Linking and anti-passback shall remain fully functional within the same Location even when the system server or workstations are off-line.
 2. In the event of communication failure between the system server and a Location, there shall be no degradation in operations at the ISCs at that Location. ISCs at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
 3. Buffered events shall be handled in a first-in-first-out mode of operation.
- D. Individual ISC Operation:

1. ISCs shall transmit alarms, status changes, and other data to the system server when communications circuits are operable. If communications are not available, ISCs shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the system server, shall be stored for later transmission to the system server. Storage capacity for the latest 1024 events shall be provided at each ISC.
 2. Card-reader ports of an ISC shall be custom configurable for at least 120 different card-reader or keypad formats (Weigand). Multiple reader or keypad formats may be used simultaneously at different ISCs or within the same ISC.
 3. ISCs shall provide a response to card readers or keypad entries in less than 0.25 seconds, regardless of system size.
 4. ISCs that are reset, or powered up from a non-powered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
 5. Initial Startup: When ISCs are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each ISC.
 6. On failure for any reason, ISCs shall perform an orderly shutdown and force ISC outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
 7. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which ISCs shall resume normal operation.
 8. After ISC failure, if the database and application software are no longer resident, ISCs shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, ISCs shall immediately resume operation. If not, software shall be restored automatically from the system server.
- E. Communications Monitoring:
1. System shall monitor and report status of serial communications loop of each Location.
 2. Communication status window shall display which ISCs are currently communicating, a total count of missed polls since midnight, and which ISC last missed a poll.
 3. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each ISC.
- F. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the system server at least once a day to plus or minus 10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.
- G. All ISCs shall be UL listed. Input points in ISCs shall be UL 294 listed.
- H. Basis of Design:
1. System Controller:
 2. Dual reader control module:
 3. Sixteen (16) Input module:
 4. Sixteen (16) Output module:

2.4 POWER SUPPLY/ENCLOSURES – ACCESS CONTROL SYSTEM

- A. All ISCs and other boards part of the access control system shall be installed inside a metal enclosure with a power supply as recommended and designed by the manufacturer of the equipment.
- B. The low voltage power supply shall convert a 115 VAC or 24 VAC 60 Hz input to a continuously supplied current of 12 or 24 VDC. The power supply shall be UL listed, fused protected and class 2 rated.
- C. The power supply shall include a battery charger to provide backup power when main power goes down. If ISC has a battery charger and input built in, then the power supply does not need this feature.
- D. Plug in transformers feeding a low voltage power supply feeding an access control panel are not allowed unless they are mounted inside another lockable enclosure. External multi-output individually fused protected outputs power supplies feeding all access control board are acceptable as long as they are located next to the access control panels.
- E. Maintenance free batteries shall be provided with all power supplies or ISC and shall be mounted inside the same enclosure. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.
- F. All enclosures for ISCs, other electronic boards, power supplies or battery cabinets shall be UL listed NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4X enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.
- G. Basis of design: Altronix

2.5 TAMPER SWITCH

- A. All security enclosures, including power supplies and terminal cabinets shall include a tamper switch for direct supervision of the cabinet door. Any opening of these doors shall initiate an alarm condition to the security monitoring system. All tamper contacts shall be a reed actuated self adjusting plunger style switch. If a tamper contact is provided by the manufacturer with the enclosure this device may be used.
- B. Tamper switches shall be wired as to report separate alarms to the system for each panel.
- C. Basis of design: DSX-1022-NV or an approved equal.

2.6 CONTACTLESS SMART CARD READER

- A. The standard smart card reader for use throughout this facility shall be a switchplate style reader in low profile weatherized polycarbonate housing suitable for mounting in either an indoor or

outdoor environment. The reader shall be constructed of a polycarbonate material sealed to a NEMA rating of 4X IP65. The reader shall contain an integral magnet for use with an external magnetic reed switch to provide tamper protection when connected to an external alarm. The reader shall be UL/C 294 listed and shall conform to FCC and ISO standards. The reader shall operate at a frequency of 13.56MHz 125KHz. All RF data transmitted between this device and the smart card shall be encrypted for additional protection using a secure algorithm. The reader shall provide an audiovisual indication to signify access granted or access denied. This operation shall be displayed by a high intensity LED light bar which shall change from red, amber, or green based on the status of the operation. The housing shall mount on an industry standard single gang electrical junction box. It shall have a read range of 4.0 to 4.5 inches when used with a standard smart access card and 1.0 to 2.0 inches when used with a key tag.

- B. The mullion style readers shall only be used where wall mounting is not possible (for example glass/aluminum store-front systems).
- C. The smart card reader with keypad shall have a standard contactless smart card and shall have a twelve (12) key keypad. Readers with keypad shall be used where indicated in design drawings.
- D. With every badging station provided for this project, a verification reader with keypad shall be provided. This reader shall also have writing capabilities to the access cards. This reader shall be provided with USB interface and a stand for desktop mount.
- E. Communications between the readers and the ISC shall be through a Wiegand interface
- F. Basis of design selection: HID i-Class SE series.

2.7 CONTACTLESS SMART CARD

- A. The contactless smart cards for the access control system shall be receptive to a standard smart card reader. Body shielding or variable environmental conditions shall have no adverse effect on their operation. The card shall be a read only type device
- B. The following card quantities shall be provided for this project.

CARD TYPE	QTY
Keyfob	
Tag with adhesive back	
Single technology card for direct printing and thermal transfer	
Single technology clamshell high durability card	

- C. All card ordered for this project shall have the same system code.
- D. All read/write cards ordered for this project shall have a 16K bit dual application area.
- E. All access cards or tags shall be purchased through the HID Corporate 1000 program with the facility code assigned to the owner.
- F. Basis of Design: HID i-Class SE

2.8 LONG RANGE UHF READER

- A. The long range UHF reader to be used at the vehicle gates as indicated in the construction drawings. The reader shall be constructed of a polycarbonate material sealed to a NEMA rating of 4X IP65. The reader shall be UL/C 294 listed and shall conform to FCC and ISO standards. The reader shall operate in the 902-928 MHz UHF band to communicate with radio frequency tags and credentials. All RF data transmitted between this device and the credential shall be encrypted for additional protection using a secure algorithm. The reader shall have a read range of 15 feet when used with an approved credential.
- B. 12 VDC power for the long range reader shall be from a general use power supply with battery backup.
- C. The long range reader shall connect to a reader port on the ACS. The reader shall communicate to the ISC through Wiegand interface
- D. Basis of design: AWID LR-2000 or an approved equal.

2.9 LONG RANGE READER CREDENTIALS

- A. Provide 100 rearview mirror UHF radio frequency tags. The tags shall be enrolled into the ACS using a site specific facility code and individual tag number. The tag shall permanently attach to the inside of the rearview mirror with the black side of the tag facing the windshield to minimize visibility. The tags shall be read by the long range UHF reader to grant access as programmed into the ACS. The tags shall communicate to the reader in Wiegand format for proper authentication with the ACS.
- B. Basis of Design: AWID RV-UHF-0-0 or approved equal

2.10 BIOMETRIC READER

- A. The biometric reader shall be a compact unit with a fingerprint sensor, a display area, a keypad and a contactless card reader unit built-in. The biometric reader shall have the following specifications:
 - 1. Transmit frequency: 13.56 MHz.
 - 2. Finger print sensor resolution: 500 DPI
 - 3. Communications: Wiegand interface
 - 4. Output format: 40,64,75,128 and 200 bit output.
 - 5. Keypad: 4X3 illuminated keypad
 - 6. Display: LCD monochrome display
 - 7. Operating voltage: 12V power supply
- B. With every badging station provided for this project, an enrollment biometric reader with keypad shall be provided. This reader shall also have writing capabilities to the iClass access cards. This reader shall be provided with USB interface and a stand for desktop mount.
- C. Basis of design: HID i-Class BKLB40.

2.11 LOCKING DEVICES – SPECIFIED UNDER DIV 8

- A. The SSI shall coordinate with the door hardware installer on the placement of electronic locking hardware required for this project. The SSI shall provide all necessary wire and cable, and the low voltage power supplies for door locks. The SSI shall also be responsible for terminating all connections and interface this equipment with the integrated security system.

2.12 DELAYED EGRESS ELECTROMAGNETIC LOCKS

- A. The delayed egress electromagnetic locks for this project shall be a NFPA 101 compliant units with a holding force of 1,500 lbs. The unit shall be able to be powered from a 12VDC or a 24 VDC power supply.
- B. The delayed egress electromagnetic lock shall have the following options at a minimum: Bypass monitor, door status switch, and dynastat force sensor.
- C. Accessories: The SSI shall provide all accessories for proper mounting of the delayed egress electromagnetic lock to the door frame such as filler plates, Z-brackets, or angle brackets.
- D. Basis of design: Dynalock 3101C – Gen II.

2.13 ELECTROMAGNETIC LOCKS

- A. The electromagnetic locks for this project shall provide a locking force of 1,500 lb. The unit shall be able to be powered from a 12VDC or a 24 VDC power supply.
- B. The electromagnetic lock shall have the following options at a minimum: bi-color LED indicator and door status switch.
- C. Accessories. The SSI shall provide all accessories for proper mounting of the electromagnetic lock to the door frame such as filler plates, Z-brackets, or angle brackets
- D. Basis of design: Dynalock 3000.

2.14 DOOR RELEASE BUTTONS (REQUEST TO EXIT SWITCH/BUTTON)

- A. Where indicated on the drawings, a door release button shall be provided to function as a secondary method of door release on locked doors. The door release button shall have the following specifications:
 - 1. Button type: Illuminated.
 - 2. Button size: two inches square
 - 3. Lettering: "Push to Exit"
 - 4. Box size: Single gang
 - 5. Contacts: Momentary DPDT or (1 SPST N/O and 1 SPST N/C) 5A @ 30 VDC
 - 6. Built-in timer: Pneumatic timer, only required when used with electromagnetic locks.
 - 7. Finish: Bright Chrome
 - 8. Basis of design: RCI 991-PTD or equal.
- B. For applications where the door release buttons will be located under a desk a rocker switch

shall be used instead of the regular exit device. The design selection for the rocker switch is the RCI 909 surface mounted.

2.15 REQUEST TO EXIT EGRESS MOTION SENSOR

- A. The egress sensors shall utilize passive infrared technology to detect the motion of individuals approaching a door. Upon activation this device shall release the lock, and shunt the magnetic door position switch to allow unobstructed egress through the door. This device shall be field adjustable to fit the monitoring requirements of the location where installed.
- B. All request to exit motion sensors shall be provided with a trim plate for mounting the detector over a standard single gang junction box.
- C. Basis of design: Detection Systems/Bosch model DS150i or an approved equal

2.16 MAGNETIC DOOR POSITION SWITCH – DPS

- A. The standard recessed door position switch shall be Interlogix 1078 series or approved equal. The contact and the magnet shall be hermetically sealed in a one piece, molded, flame retardant ABS plastic housing for maximum strength and durability. The contact and magnet shall snap-lock into a predrilled 3/4" or 1" diameter hole. Color of the housing shall be off white, gray, or mahogany, and shall be provided in the appropriate color to match the door and doorframe. The magnet shall be made of Alnico V.
- B. The standard position switch for a roll up door shall be an Interlogix 2207AH high security contact or approved equal.
- C. On banks of doors where multiple doors are being monitored, door contacts shall be wired in series. All double doors shall receive (1) magnetic door position switch on each door leaf and shall report as one alarm point.
- D. On exterior doors with impact resistant listings, use only surface mounted door position switches in lieu of the standard recessed door position switches. The design selection is the Interlogix 1085T or approved equal.

2.17 DURESS PANIC BUTTON – UNDER DESK

- A. The unit shall consist of a housing that contains the electrical circuitry and magnetic reed contact, a cover plate to protect the internal electronics and actuating lever with an Alnico-V magnet installed in the cradle lever. The alarm shall occur when the actuating lever is moved 20 to 45 degrees past the fully closed position. The unit shall feature a glowing LED for low light visibility, when powered up this shall be lighted green, when activated this light shall glow red. The unit shall be mounted in specific locations of rooms indicated on the drawings. Obtain client approval on these locations prior to locating these devices.
- B. Basis of design: Interlogix 3040 series panic switch or an approved equal.

2.18 DURESS PANIC BUTTON- WALL MOUNTED

- A. The duress panic button wall mounted shall be a mushroom type button capable of fitting in a dual gang box with a single device adapter. The specifications of the duress panic button – wall mounted are:
 - 1. Operation: push button once to engage, twist cap in direction of arrows to release.
 - 2. Plate construction: ¼” extruded aluminum plate
 - 3. Switch mode operation: latching maintained action.
 - 4. Switch configuration: SPDT
 - 5. Button finish: red cap.
 - 6. Screws: tamper resistant.
- B. Basis of design: Rutherford controls International model 919 or similar.

2.19 SURGE PROTECTION

- A. All security components mounted outside the building and wired through low voltage copper conductor back to the building shall be provided with surge and lightning protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. For RS-485 or RS-422 connections provide PC642C-008LC with base PCB1B manufactured by EDCO or an approved equal.
- B. For exposed Ethernet connections with PoE, use EDCO CAT6-E PoE or approved equal.

2.20 POWER SUPPLY – DOOR LOCKING HARDWARE AND SENSORS

- A. Power supplies for door locks or powered sensors (i.e. request to exit motion sensors) shall be completely separate from power supplies for ISC or electronic hardware part of the card access system.
- B. The power supply for door locks and powered sensors shall convert a 115 VAC 60 Hz input to a continuously supplied current of 24 VDC. The power supply shall be UL listed, NFPA compliant, and have multiple class 2 rated outputs. The power supply shall be housed in NEMA 1 hinged cover enclosures where mounted indoors and in fully weatherproof NEMA 4 enclosures when located outdoors or in an exposed or covered area. All enclosure doors shall be key lockable, keyed alike, and shall include a tamper switch for monitoring by the security system. Any cabinet opening shall initiate an alarm condition to the security monitoring system.
- C. The power supply for door locks and powered sensors shall include a battery charger and a battery input to provide power to the locks after a main power system failure. The switchover to stand-by battery shall be automatic when main AC power fails.
- D. Power supplies for regular locking hardware shall be installed next to access control panels.
- E. Maintenance free batteries shall be provided with all power supplies. Batteries shall be sized to allow at least 4 hours of power backup. All power supplies shall be monitored for low battery through the access control system.

- F. The power supply for door locks and powered sensors shall have the following features:
 - 1. Number of outputs: 16 [8] programmable as fail-safe or fail secure individually
 - 2. Fire alarm disconnect: Yes, latching or unlatching and individually selectable for any of the inputs.
 - 3. Output protection: PTC [fused]
 - 4. Monitoring: AC fail and low battery with dry contact closure.
- G. Basis of design: Altronix Maximal series.

2.21 LOCAL ALARM

- A. The local alarm shall be a buzzer with strobe light that mounts in a double gang electrical box. The buzzer shall have an output capacity of 70 db @ 10 ft. from the source and. The strobe light shall radiate light at 75 cd.
- B. The local alarm shall be white and shall have no lettering.
- C. Basis of design: Gentex GEC3-12PWW or approved equal.

2.22 VEHICLE CARD READER, CAMERA, AND INTERCOM PEDESTAL

- A. The custom pedestal shall be manufactured from 2-inch aluminum square tubing with a welded backplate and a square mounting baseplate with tapped holes. The stand shall include a fitted flange cover to conceal the mounting baseplate and associated fasteners required to secure this unit to the concrete platform. The enclosure shall be an aluminum design with a secure cover to prevent unauthorized access. This enclosure shall be weatherproof to protect electronics from environmental conditions. Dimensions and configuration of the pedestals shall be as indicated the design drawings.

2.23 KEY SWITCH

- A. The key switch shall be a capable of fitting in a dual gang box with a single device adapter. The specifications of the key switch are:
 - 1. Plate construction: 1/4" extruded aluminum plate
 - 2. Switch mode operation: maintained action.
 - 3. Switch configuration: one SPDT and one DPDT
 - 4. Cylinder: Match owner's keying standard.
 - 5. Screws: tamper resistant.
 - 6. LED: bi-color (red-green) mounted in plate.
 - 7. Design selection: Rutherford controls International model 960 or similar.

2.24 SLIDE GATE OPERATOR

- A. All slide gate operators for this project shall be provided under this scope of work. The placement of all gate controllers shall be coordinated with the locations shown civil and electrical documents. All gates shall be interfaced with the security system to restrict vehicle access into controlled areas.

- B. The slide gate controller shall be designed for high traffic use, commercial grade and continuous cycle operation with gates up to 1,500 pounds in weight and 45 feet in length. It shall use a solid steel machined pulley and notched v-grove belt for high efficient torque transfer from the motor to the gear reducer. The unit shall be suitable for Class I, II, III and IV applications.
- C. All control operations shall be provided through an advanced electronic control board that incorporates input and output control points on a solid state circuit board. Plug-in loop detectors shall be included for reverse detection.
- D. The slide gate operator shall utilize a 1HP instant reversing 115VAC 7 amp motor with a precision limit switch system. The slide gate operator shall be ETL listed or UL 325 and UL 991 listed.
- E. At a minimum each slide gate operator shall be provided with two (2) safety loops and sensors to prevent accidents.
- F. Basis of design: NKS DoorKing model 9150 or approved equal.

2.25 BARRIER GATE OPERATOR

- A. All barrier gates for this project shall be provided under this scope of work. The placement of all barrier gate controllers shall be coordinated with the locations shown civil and electrical documents.
- B. The gate arm shall be constructed of wood, plastic or aluminum. The gate arms shall be 14' in length or less depending on the size of the road. The gate arm shall be internally counterbalanced with 2 to 4 adjustable extension springs depending on the overall length of the gate arm. The barrier gates shall utilize loop detectors to prevent the gate from closing when a vehicle is located below the barrier arm. The gate shall also provide a means of sensing if the arm has encountered an obstruction during the up or down cycle. If an obstruction is encountered, the gate shall return to the beginning of the cycle, and wait five seconds before trying again.
- C. Non-directional vehicle loop sensors shall be used at the gates as shown on the contract drawings. The sensors shall detect the presence of a vehicle for gate opening during egress, and shall prevent the gate arm from closing on a vehicle while passing under an open gate. The detector shall resist lighting induced power surges on the detector loop by using a loop transformer between the loop and loop circuitry.
- D. The barrier gate operator shall use a 115 VAC power supply and shall have a ½ HP continuous-duty motor. Only adjustments to the internal springs shall be required to compensate for gate arm of various lengths. The speed of the motor shall be adjustable by varying the voltage to the motor. All barrier gates must be grounded for protection from lightning strikes and power surges. The unit shall be suitable for Class I, II, III and IV applications
- E. The barrier gate operator shall be able to provide a dry-contact to the access control system indicating if the gate arm is in the up position (open contact) or in the down position (close contact). •The gate arm shall rotate 90° in approximately 1.5 seconds.

- F. Basis of design: DKS DoorKing 1601 with required accessories to achieved the described operation.

2.26 IMPACT SENSOR

- A. All slide gate operators shall be provided with a safety sensor to reverse the direction of the gate upon contact with an obstruction. The safety sensor for the sliding gates shall be a Miller-Edge model MU22 yellow color with XR5 chemical resistant cover.
- B. All safety sensors shall be interfaced with a safety edge transmitter which shall be the device which sends the signal to the gate operator when an obstruction is encountered. The safety edge transmitter shall be model MGT manufactured by Linear Access.

2.27 EXTERIOR EQUIPMENT HOUSING

- A. NEMA 4X rated stainless steel enclosures shall be provided to house electronic security equipment to all vehicle gates. The enclosure shall be constructed of 14 gauge stainless and shall have dimensions as required to hold electronics
- B. All enclosures shall be provided with a pad lock and a tamper switch for direct supervision. Any door opening shall initiate an alarm condition to the security monitoring system. All cores shall be keyed alike. A grounding package shall be provided for connection to a ground rod. A #8 solid copper ground wire shall be provided and installed from the ground lug to a grounding rod installed next to the enclosure.
- C. All exterior enclosures shall include a compact air condition unit. The air condition unit shall be as indicated in the design drawings. All air condition units shall be monitored for proper operation through relay contacts through the access control system.
- D. Basis of design: nVent Watershed, Type 4X

2.28 LOOP DETECTORS

- A. Loop detectors shall be used to detect the presence of a vehicle in the spot where the loop detector is installed. Loop detectors shall be used as indicated in the design drawings to control gates, or to notify the presence of a vehicle in a specific area.
- B. The loop detector system shall have the following specification:
 - 1. The unit shall have loop diagnostics, a loop isolation transformer and loop conditioner.
 - 2. The unit shall have aluminum RF shield housing, surge protection and a loop frequency counter.
 - 3. The unit shall have sensitivity controls (10 levels), function controls and operation controls, through dip switch settings.
 - 4. Unit shall operate at 12 V AC/DC or 24 V AC/DC.
 - 5. Unit shall have at least two outputs on SPDT contacts.
- C. The size of the loop shall be as recommended by gate ISC manufacturer. The SSI shall estimate the number on turns to ensure a maximum detection height of 3.2 ft from the ground.

- D. After the wire loop is installed the SSI shall seal the opening only with a commercial type loop sealant designed for traffic loops. The SSI shall install wire loops with backer rod to prevent the wire from moving. For sealants and baker rods use RAI products or similar manufacturer.
- E. Loop detectors shall be installed inside a metal enclosure in the secure side of the gate. Loop detector can be installed inside the enclosure for the gate operator or in a separate Stainless Steel NEMA 4X enclosure sized for the dimensions of the devices.
- F. Power for the loop detectors shall be provided from the gate operator or from a power supply located in the telecommunications closet, when the loop is not part of the gate safety or request to exit features.
- G. Basis of design: D-Tek loop detector by EMX industries or recommended device by manufacturer of gate operator.

2.29 DIN-RAIL MOUNTED RELAYS

- A. General Description: Any time the access control system needs to switch any load that is not considered a Class 2 circuit as defined in the NEC article 725, or any load that works at voltages higher than 24 V (AC or DC) an external relay shall be used to switch the load. The Access control relay from an RIM or and OCM shall drive the coil of the external relay which contacts shall control the load. These additional relays shall always be mounted in a DIN rail and will be references in this specification as the DIN-rail mounted relays. These DIN rail mounted relays shall have the following specifications:
 - 1. Number of contacts: 2 –Poles
 - 2. Contact type: Form C
 - 3. Contact material: AgCdO (silver tin oxide) or Gold plating
 - 4. Contact rating: 8 A minimum or as required by load
 - 5. Insulation voltage: 250V IEC, 300V UL
 - 6. Coil voltages: 24 VDC
 - 7. Enclosure design: Slim line design. Width less than 0.5”
- B. All DIN rail mounted relays shall be provided with a base made of molded high dielectric material, with terminal screw sockets for all contacts. All bases shall be capable of mounting on a standard DIN (#3) 35 mm wide rail and shall be of the screw terminal type.
- C. All DIN rail mounted relays shall be provided with end clamps at the ends of each row of devices and shall be mounted inside security enclosures.
- D. Basis of design: Rockwell Automation series 700-HK or equal.

2.30 DIN-RAIL MOUNTED TERMINAL BLOCKS

- A. General Description: When multiple terminations are required for cabling part of the security system separate from the termination blocks mounted on the access control equipment, DIN rail mounted terminal blocks shall be used to make all wire termination. Other termination methods such as wire nuts, crimp on connectors, shall not be used. The specifications of the DIN rail mounted terminal blocks are:

1. Block type: Feed-through block, for single conductor or two conductors, modular system. SSI to select according to application. Block shall be specifically designed for mounting on a DIN rail. Other types of blocks designed for direct surface mounting on a panel are not allowed.
 2. Termination type: Captive screw connection.
 3. Wire range per contact: AWG 28 to AWG 12
 4. Maximum voltage rating: > 600V AC/DC
 5. Maximum current rating: >20 A
 6. Size: Termination block shall separate termination point from enclosure back panel no less than 0.5"
- B. DIN rail mounted termination blocks shall be provided with all accessories including: DIN rail, end barriers, end anchors and jumpers.
- C. Basis of design: Allen-Bradley 1492 series blocks, or similar from Eaton or Phoenix Contact.

2.31 WIRE & CABLE

- A. Cables for un-powered security sensors shall have the following specification:
1. Minimum cable gauge: AWG 20
 2. Number of conductors: 2, stranded conductors
 3. Conductor type: Bare copper
 4. Cable insulation: Color coded PVC
 5. Conductor insulation colors: Black and red.
 6. Voltage rating: 300V
 7. Cable shield: No cable shields
- B. Cables for powered security sensors shall have the following specifications:
1. Minimum cable gauge: AWG 20
 2. Number of conductors: 4, stranded conductors
 3. Conductor type: Bare copper
 4. Cable insulation: Color coded PVC
 5. Conductor insulation colors: Black, red, white and green.
 6. Voltage rating: 300V
 7. Cable shield: No cable shields
- C. Cables for access control readers shall have the following specifications:
1. Minimum cable gauge: AWG 22
 2. Number of conductors: 6, stranded conductors
 3. Conductor type: Tinned copper
 4. Cable insulation: Color coded PVC
 5. Conductor insulation colors: Black, red, white, green, orange (or brown) and blue.
 6. Voltage rating: 300V
 7. Cable shield: Aluminum/polyester foil (overall) with a AWG 24 tinned copper drain wire
- D. Cables for RS-232, RS-422 or RS-485 control lines shall have the following specifications:
1. Minimum cable gauge: AWG 24
 2. Number of conductors: 2-paired, stranded conductors
 3. Conductor type: Tinned copper

4. Cable insulation: Polyethylene
 5. Conductor insulation colors: White-blue, blue-white white-orange and orange-white
 6. Voltage rating: 300V
 7. Cable shield: Aluminum/polyester foil (overall), a tinned copper braid (90% coverage) and a AWG 24 tinned copper drain wire
 8. Nominal characteristic impedance: 120 Ohms
 9. Nominal capacitance: 12.8 pF/ft.
 10. Nominal delay: 1.6 ns/ft.
 11. Nominal attenuation: 0.6 dB/100 ft @ 1 MHz.
- E. Cables for door locks and low voltage power supplies shall have the following specifications:
1. Minimum cable gauge: AWG 18
 2. Number of conductors: 2, stranded conductors
 3. Conductor type: Bare copper
 4. Cable insulation: PVC
 5. Conductor insulation colors: Black and red.
 6. Voltage rating: 300V
 7. Cable shield: No cable shields
- F. Cables for loop detectors shall have the following specifications:
1. Minimum cable gauge: AWG 16
 2. Number of conductors: 1, stranded conductors
 3. Conductor type: Bare copper
 4. Cable insulation: Cross-linked polyethylene (XLPE)
 5. Conductor insulation colors: Black
 6. Voltage rating: 600V
 7. Cable shield: No cable shields
- G. All UTP Category horizontal cables and fiber optic cables for the security system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000.
- H. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The SSI shall always estimate proper values.
- I. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits. All spaces above ceilings in this project shall be treated as plenum spaces. All cables with a NEC type TC shall be run fully in conduit from the panel to the device and shall be separated from other communication or Class 2 rated cables.
- J. Cable jackets for this project: Except when cables are run continuously in conduit all cable jackets for access control cables shall be plenum rated.
- K. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.
- L. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.32 IDENTIFICATION AND LABELING TAGS

- A. The SSI shall follow labeling materials indicated in specification section 270010

PART 3 - EXECUTION

3.1 SECURITY DOORS FUNCTIONALITY

- A. The following paragraphs described the expected functionality of the typical security doors. The SSI shall use this description to draw the one line diagrams part of the shop drawings and described in part 1 of this specification. The SSI shall make sure the proposed wiring for each door type produces the desired functionality for each door type.
- B. All control logic for this functionality shall be accomplished through local input/output events. Global events to accomplish these requirements are not allowed. Failure of the access control server shall not limit the functionality of the doors. When the word reader is used in the following descriptions, it means it is a generic device, it could be any type of reader (biometric, iClass, prox) with or without keypad, see the design drawings for particular selection for every door.
- C. Devices indicated in the following paragraph as provided by Door Hardware Installer are only the devices that are associated with the security system. For further instructions of additional passive door hardware devices to be provided, see Division 8 specifications.
- D. DOOR TYPE A1 (Single emergency only exit)
 - 1. Door type:
 - a. Single leaf,
 - 2. Door mode:
 - a. Emergency only.
 - 3. Devices on secured side:
 - a. One (1) Door position switch
 - b. One (1) Local Alarm.
 - 4. Devices on unsecured side:
 - a. None.
 - 5. Door operation:
 - a. From secured side: Door shall be opened by mechanical means by pressing the panic bar. The local alarm shall be activated as long as the door is opened.
 - b. From unsecured side: door can't be opened.
 - c. Key override: None.
 - d. Local alarm reset: A single click command from any access control workstation with access to this door shall silence the alarm for given period of time.
 - 6. Reported Alarms:
 - a. Door opened.
- E. DOOR TYPE A3 (Single emergency only exit with delayed egress,)
 - 1. Door type:
 - a. Single leaf,
 - 2. Door mode:
 - a. Emergency only.

3. Devices on secured side:
 - a. One (1) Power transfer,
 - b. one (1) UL listed delayed egress panic device,
 - c. one (1) power supply with door lock, batteries and fire alarm release,
 - d. one (1) Door position switch,
 - e. one (1) Local Alarm,
 - f. one (1) tamper switch and a form C relay for fire alarm release.
 4. Devices on unsecured side:
 - a. None.
 5. Door operation:
 - a. From secured side: After pressing the panic device for more than 3 seconds the panic device shall go into an irreversible process that unlocks the door after 15 seconds and activates the local alarm. Door shall be opened by mechanical means by pressing the panic bar after the 15 seconds.
 - b. From unsecured side: door cannot be opened.
 - c. Key override: Key override will be provided in the built-in key switch in the panic devices.
 - d. Fire alarm release: The door shall be unlocked immediately upon activation of the sprinkler system, a heat detector or no more than 2 smoke detectors in the building.
 - e. Alarm reset and door relock: Panic device shall be reset and re-armed after momentary activation of the built-in key switch. This same action shall be possible from a single click command from any access control workstation with access to this door. Resetting the panic device shall also turn off the local alarm.
 6. Reported Alarms:
 - a. Door forced open.
 - b. Irreversible process started at the exit device.
 - c. Power supply tamper
 - d. AC failure (if available in power supply).
 - e. Battery low (if available in power supply).
- F. DOOR TYPE B1 (Single controlled entry/exit with delayed egress)
1. Door type:
 - a. Single leaf.
 2. Door mode:
 - a. Emergency and operational door.
 3. Devices on secured side:
 - a. one (1) Power transfer,
 - b. one (1) listed delayed egress panic device with electric trim,
 - c. one (1) power supply with door lock, batteries, fire alarm release and control circuit,
 - d. one (1) door position switch (DPDT),
 - e. one (1) reader or request to exit switch as indicated in floor plans,
 - f. one (1) tamper switch and a form C relay for fire alarm release
 4. Devices on unsecured side:
 - a. one (1) reader or request to exit push button as indicated in floor plans
 5. Door operation:
 - a. From secured side: After pressing the panic device for more than 3 seconds the panic device shall go into an irreversible process that unlocks the door after 15 seconds. Door shall be opened by mechanical means by pressing the panic bar after the 15 seconds. Door shall also be opened by mechanical means after a valid

- transaction at the reader or request to exit switch without delay and without setting off any alarms. Door alarms shall be bypassed for a fixed period of time.
- b. From unsecured side: Door shall be opened by mechanical means after a valid transaction at the reader or a momentary request to exit signal causing the lock in the trim to be released. Door alarms shall be bypassed for a fixed period of time.
 - c. Key override: Key override will be provided in the built-in key switch in the panic devices.
 - d. Fire alarm release: The door shall be unlocked immediately upon activation of the sprinkler system, a heat detector or no more than 2 smoke detectors in the building.
 - e. Alarm reset and door relock: Panic device shall be reset after a valid transaction at the reader and it shall be re-armed after the door is closed. This same action shall be possible from a single click command from any access control workstation with access to this door.
6. Reported Alarms:
- a. Door forced open.
 - b. Irreversible process started at the exit device.
 - c. Invalid, lost or stolen card presented at the reader.
 - d. Door held open. Installer to coordinate with the owner held open time in a per door basis
 - e. Power supply tamper
 - f. AC failure (if available in power supply).
 - g. Battery low (if available in power supply).
- G. DOOR TYPE B2 (Double controlled entry/exit with delayed egress)
- 1. Door type:
 - a. Double leaf, non ADA
 - 2. Door mode:
 - a. Emergency and operational door.
 - 3. Devices on secured side:
 - a. Two (2) Power transfers,
 - b. two (2) UL listed delayed egress panic device with electric trim,
 - c. one (1) power supply with door lock, batteries, fire alarm release and control circuit,
 - d. two (2) door positions switches DPDT,
 - e. one (1) reader or request to exit switch as indicated in floor plans,
 - f. one (1) tamper switch, a form C relay for fire alarm release.
 - 4. Devices on unsecured side:
 - a. One (1) reader or request to exit push button as indicated in the floor plans.
 - 5. Door operation:
 - a. From secured side: After pressing either panic device for more than 3 seconds both panic devices shall go into an irreversible process that unlocks both leaves after 15 seconds. Doors shall be opened by mechanical means by pressing the panic bar after the 15 seconds. Doors shall also be opened by mechanical means after a valid transaction at the reader or request to exit switch without delay and without setting off any alarms. Door alarms shall be bypassed for a fixed period of time.
 - b. From unsecured side: Door shall be opened by mechanical means after a valid transaction at the reader or a momentary request to exit signal causing the lock in the trim to be released. Door alarms shall be bypassed for a fixed period of time.
 - c. Key override: Key override will be provided in the built-in key switch in the panic devices.

- d. Fire alarm release: The door shall be unlocked immediately upon activation of the sprinkler system, a heat detector or no more than 2 smoke detectors in the building.
 - e. Alarm reset and door relock: Panic devices shall be reset after a valid transaction at the reader and it shall be re-armed after door is closed. This same action shall be possible from a single click command from any access control workstation with access to this door.
 - 6. Reported Alarms:
 - a. Door forced open, either leaf as one alarm.
 - b. Irreversible process started at the exit device, either leaf as one alarm.
 - c. Invalid, lost or stolen card presented at the reader.
 - d. Door held open, either leaf as one alarm. Installer to coordinate with the Owner held open time in a per door basis
 - e. Power supply tamper
 - f. AC failure (if available in power supply).
 - g. Battery low (if available in power supply).
- H. DOOR TYPE C1 (Single monitored door)
 - 1. Door type:
 - a. Single leaf
 - 2. Door mode:
 - a. Operational door.
 - 3. Devices on secured side:
 - a. One (1) Door position switch.
 - 4. Devices on unsecured side:
 - a. None.
 - 5. Door operation:
 - a. From secured side or unsecured side: Door shall be opened by mechanical means using the door lock.
 - 6. Reported Alarms:
 - a. Door opened if alarm point is armed.
 - b. No alarms if alarm point is disarmed.
- I. DOOR TYPE C2 (Dual monitored door)
 - 1. Door type:
 - a. Double leaf
 - 2. Door mode:
 - a. Operational door.
 - 3. Devices on secured side:
 - a. Two (2) Door position switches.
 - 4. Devices on unsecured side:
 - a. None.
 - 5. Door operation:
 - a. From secured side or unsecured side: Door shall be opened by mechanical means using the door lock.
 - 6. Reported Alarms:
 - a. Door opened if alarm point (both leaves reporting as one alarm) is armed.
 - b. No alarms if alarm point is disarmed.
- J. DOOR TYPE C3 (Single controlled entry with mortise lock, free exit, non-emergency)
 - 1. Door type:
 - a. Single leaf

2. Door mode:
 - a. Operational door.
 3. Devices on secured side:
 - a. One (1) Power transfer,
 - b. one (1) electric mortise lock with request to exit switch built in and
 - c. one (1) door position switch.
 4. Devices on unsecured side:
 - a. One (1) reader, as indicated in floor plans.
 5. Door operation:
 - a. From secured side: Door shall be opened by mechanical means using the electric mortise lock. Activation of the built-in request to exit switch in the lock shall bypass all door alarms for a fixed period of time. From unsecured side: Door shall be unlocked by releasing the lock after a valid transaction at the reader. Door alarms shall by bypassed for a fixed period of time.
 - b. Key override: The use of a valid key in the lock's cylinder shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
 - c. Fail mechanism: door lock shall be fail secure.
 6. Reported Alarms:
 - a. Door forced open.
 - b. Invalid, lost or stolen card presented at the reader.
 - c. Door held open. Installer to coordinate with the Owner held open time in a per door basis.
- K. DOOR TYPE C4 (Double controlled entry with mortise lock, free exit, non-emergency)
1. Door type:
 - a. Double leaf, one active, one inactive
 2. Door mode:
 - a. Operational door.
 3. Devices on secured side:
 - a. One (1) Power transfer,
 - b. one (1) electric mortise lock with request to exit switch built in and
 - c. two (2) door position switches.
 4. Devices on unsecured side:
 - a. One (1) reader, as indicated in floor plans.
 5. Door operation:
 - a. From secured side: One leaf shall be opened by mechanical means using the electric mortise lock. Activation of the built-in request to exit switch in the lock shall bypass all door alarms for a fixed period of time. Second leaf shall only be opened by mechanical means after other leaf is opened. From unsecured side: One leaf shall be unlocked by releasing the lock after a valid transaction at the reader. Door alarms shall by bypassed for a fixed period of time.
 - b. Key override: The use of a valid key in the lock's cylinder shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
 - c. Fail mechanism: door lock shall be fail secure.
 6. Reported Alarms:
 - a. Door forced open, either leaf as one alarm.
 - b. Invalid, lost or stolen card presented at the reader.
 - c. Door held open, either leaf as one alarm. Installer to coordinate with the Owner held open time in a per door basis.

- L. DOOR TYPE C5 (Single controlled entry/exit, non-emergency)
 - 1. Door type:
 - a. Single leaf
 - 2. Door mode:
 - a. Operational door.
 - 3. Devices on secured side:
 - a. One (1) Power transfer,
 - b. one (1) electric mortise lock
 - c. one (1) door position switch
 - d. and one (1) reader, as indicated in the floor plans.
 - 4. Devices on unsecured side:
 - a. One (1) reader, as indicated in floor plans
 - 5. Door operation:
 - a. From secured side: Door shall be unlocked by releasing the lock after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time. From unsecured side: Door shall be unlocked by releasing the lock after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
 - b. Key override: The use of a valid key in the lock's cylinder shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
 - c. Fail mechanism: door lock shall be fail secure.
 - 6. Reported Alarms:
 - a. Door forced open.
 - b. Invalid, lost or stolen card presented at the reader.
 - c. Door held open. Installer to coordinate with the Owner held open time in a per door basis.
- M. DOOR TYPE C6 (Double controlled entry with electric trim, free exit, emergency)
 - 1. Door type:
 - a. Double leaf, both active
 - 2. Door mode:
 - a. Operational door.
 - 3. Devices on secured side:
 - a. Two (2) Power transfer,
 - b. two (2) panic devices with RX switches and
 - c. two (2) door position switches.
 - 4. Devices on unsecured side:
 - a. One (1) reader, as indicated in floor plans, and one electrified trim
 - 5. Door operation:
 - a. From secured side: Either leaf shall be opened by mechanical means using the panic device. Activation of the built-in request to exit switch in the lock shall bypass all door alarms for a fixed period of time. From unsecured side: One leaf shall be unlocked by releasing the lock after a valid transaction at the reader. Door alarms shall be bypassed for a fixed period of time.
 - b. Key override: The use of a valid key in the lock's cylinder shall unlock the door and allow the door to be opened, but if used without a valid reader transaction, a door forced open alarm shall be initiated.
 - c. Fail mechanism: door lock shall be fail secure.
 - 6. Reported Alarms:
 - a. Door forced open, either leaf as one alarm.
 - b. Invalid, lost or stolen card presented at the reader.

- c. Door held open, either leaf as one alarm. Installer to coordinate with the Owner held open time in a per door basis.
- N. DOOR TYPE E1 (Elevator door, controlled movement)
 - 1. Door type:
 - a. Elevator, inside cab
 - 2. Door mode:
 - a. Operational door.
 - 3. Devices inside cab:
 - a. One (1) reader and
 - b. one (1) intercom substation as indicated in floor plans.
 - 4. Door operation:
 - a. A valid transaction at the card reader shall enable, for a pre determined period of time) some or all buttons in the elevator cab to select the floor the user is intending to go. The user needs to physically press the button of the desired floor to activate the request. Each button on the elevator cab shall have individual control to allow access in a per floor basis to card holders.
 - b. Floor unlock shall be possible to allow users to access a predetermined floor (with one or more elevator cabs in the same elevator bank) without the use of a card.
 - c. From the access control system remote enabling of each button shall be possible.
 - 5. Reported Alarms:
 - a. Invalid, lost or stolen card presented at the reader.
- O. DOOR TYPE E2 (Elevator door, controlled call)
 - 1. Door type:
 - a. Elevator call, outside cab
 - 2. Door mode:
 - a. Operational door.
 - 3. Devices at elevator door:
 - a. One (1) reader a as indicated in floor plans.
 - 4. Door operation:
 - a. A valid transaction at the card reader shall enable both elevator call buttons, for a pre determined period of time, for one of the elevators in the bank only. The user needs to physically press the call button to activate the request. Both buttons (up or down) shall have a common control to allow access in both directions.
 - b. Floor unlock shall be possible to allow users to call the elevator in a predetermined floor without the use of a card.
 - c. From the access control system remote enabling of the call buttons shall be possible.
 - 5. Reported Alarms:
 - a. Invalid, lost or stolen card presented at the reader.
- P. DOOR TYPE D1 (roll up door)
 - 1. Door type:
 - a. Roll up door
 - 2. Door mode:
 - a. Operational door.
 - 3. Devices on secured side:
 - a. One (1) roll up door operator (with no door release buttons by the door),
 - b. safety features (photo eyes or impact sensors) and
 - c. one (1) door position switch

4. Devices on unsecured side:
 - a. None.
5. Door operation:
 - a. Door shall also be opened or closed automatically by activation of door release buttons by the door.
6. Key override:
 - a. There will be no key override for these doors.
7. Reported Alarms:
 - a. Door opened if alarm point is armed. No alarms if alarm point is disarmed.

Q. DOOR TYPE Z1 (Controlled entry/free exit vehicular gate)

1. Door type:
 - a. Vehicular gate
2. Door mode:
 - a. Operational door.
3. Devices on secured side:
 - a. One (1) dual gate operator with safety features (safety loops or photo eyes),
 - b. one (1) loop detector,
 - c. two (2) door position switches and
 - d. one (1) tamper switch.
4. Devices on unsecured side:
 - a. One (1) pedestal with camera, and a reader as indicated in floor plans.
5. Door operation:
 - a. From secured side (exit side):
 - 1) Gate shall be opened for a fixed period of time after activation of the loop detector.
 - 2) Gate alarms shall be by-passed for a fixed period of time.
 - b. From unsecured side (entry side):
 - 1) Gate shall be opened for a fixed period of time after a valid transaction at the reader.
 - 2) Gate alarms shall be by-passed for a fixed period of time.
 - c. Activation of the safety loop shall not let the gate closed until cleared.
6. Reported Alarms:
 - a. Gate enclosure tamper.
 - b. Invalid, lost or stolen card presented at the reader.
 - c. Gate held open: Gate opened after opening time expired. Installer to coordinate with the Owner held open time in a per door basis.

R. DOOR TYPE Z2. (Controlled entry/controlled exit man gate)

1. Door type:
 - a. Man Gate, single leaf
2. Door mode:
 - a. Operational door.
3. Devices on secured side:
 - a. One (1) 1500 lb electromagnetic lock with a built in door position switch and a conduit adapter
4. Devices on unsecured side:
 - a. One (1) reader a reader as indicated in floor plans.
5. Door operation:
 - a. From secured side or unsecured side: Door shall be unlocked by releasing the electromagnetic lock at the gate after a valid transaction at the reader.

6. Reported Alarms:
 - a. Door forced open
 - b. Invalid, lost or stolen card presented at the reader.
 - c. Door held open. Installer to coordinate with the owner held open times in a per door basis.

3.2 SECURITY SYSTEM INTEGRATION

- A. General: A. The access control system software shall integrate with the other security system components as indicated in this section. The SSI shall be responsible for programming all security systems in such a way that interaction between the different systems is achieved to provide a higher degree of security in the building. The minimum required integration features between the access control and the other security systems are described below:

- B. ACCESS CONTROL AND DIGITAL VIDEO RECORDING SYSTEM

1. The Access control software proposed shall integrate with the new Digital Video Recording System (DVRs) proposed for this project (refer to specification section 282000 for details on the Digital Video Recording System). The integration shall make the following features possible from the Access Control GUI:
 - a. Event video tagging. Selectable security events in the access control system shall tag the recorded video, so when the operator reviews the event, video from that moment in time when the event took place shall be retrieved automatically and brought into a window of the access control GUI.
 - b. DVRs playback control: Through the access control GUI, the operator shall be capable of controlling the video playback. The operator shall be capable of retrieving any recorded video from any camera by using a time search or an event search. The operator shall be capable of controlling the speed of the playback by selecting frame by frame playback or playback at higher speeds.
 - c. Live video: The operator shall be capable of displaying live video in window in the access control GUI. The operator shall be capable of selecting the camera in the system that he/she wants to see. Up to 4 live video windows (live or recorded) shall be possible in every workstation running the access control GUI.
 - d. PTZ Control: The operator shall be capable of controlling all PTZ features of a camera by simply using buttons in the Access Control screen with the orientation of movement.
 - e. Alarm event: Any alarm event (like video analytic alarms, or video motion detection) in the DVRs shall be transferred to the access control system for processing as any other alarm in the access control system. Alarms shall be uniquely identified in the access control system.
 - f. Status events: Any status events (system errors, or administration events) in the DVRs shall be transferred to the access control system for processing as any other status event in the access control system. Events shall be uniquely identified in the access control system.
 - g. Export/load video file: the operator shall be able to export or load video files compatible with the recording format of the DVRs from the access control GUI.
 - h. Recorder authentication: Since login is required for most DVRs, the login action on the Access Control System shall also grant access to the DVRs. Separate or further login to the DVRs shall not be required.
 - i. Dry contact control: The operator shall be capable of triggering relay contacts part of the DVRs equipment from the access control GUI.

- j. Video locking: The operator shall be capable of locking video on the DVRS to prevent it from being purged accidentally. Locked video can be set to automatically purge or archive based on user defined thresholds.

C. CCTV SYSTEM

1. Activation of access control system alarms (like door held open, door forced open, stolen/lost card used, duress alarm, alarms coming from other systems, etc) shall call presets in the nearest CCTV cameras (one or more) to point towards the device that is in alarm. This action shall take place without any operator's intervention.
2. Activation of access control system alarms shall call any associated camera to the triggered alarm to the operator's workstation alarm monitor. This action shall take place without any operator's intervention. When the alarm is cleared by the operator the image of the alarm monitor shall be removed. Alarms from doors in detention areas shall be received in the monitors in Master Control Room, alarms from doors in other areas shall be received in Building control room.
3. Video loss alarm: loss of video signal on any of the surveillance cameras in the system shall trigger an alarm in the access control system.
4. Graphic substation calling: Intercom substations shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically create a call to that substation from the master station associated with the user workstation initiating the command.
5. Graphic camera calling: Surveillance cameras shall be represented with graphic icons in the graphic maps part of the Access control system GUI. Double clicking on those icons shall automatically open a video window with a live stream from that camera.

D. INTERCOM SYSTEM

1. Alarm event: Activation of an intercom substation (or code blue assistance station) shall be treated as an access control alarm event, calling camera presets and calling any associated cameras to the operator's alarm monitors. This action shall take place without any operator's intervention. Substations in detention areas shall generate those alarms in Master Control room while substations in building exterior or elevators (except the prisoner elevator) shall generate those alarms in Building control room.
2. Automatic call: Alarms from doors with intercom substations installed by the door shall generate an automatic call to the master station in the monitoring rooms from the substation. The call shall be placed to the same master station that the substation is programmed to call when user pushes the call button.
3. Remote door release: During a call from a substation by an access controlled door to a master station, the user in the master station side shall be capable of opening the door by pressing a key in the master station keypad. This action shall not create any alarm conditions in the access control system.
4. Graphic substation calling: Intercom substations shall be represented with graphic icons in the graphic maps part of the access control system GUI. Double clicking on those icons shall automatically create a call to that substation from the master station associated with the user workstation initiating the command.
5. Graphic status: intercom substations in use in the system shall be represented with a different color (red) from stations not used (green) in the graphic maps part of the access control system GUI.

E. DOOR ENTRY SYSTEM

1. Remote door release: During a call from a substation by an access controlled door to a master station, the user in the master station side shall be capable of opening the door by

pressing a key in the mater station keypad. This action shall not create any alarm conditions in the access control system.

F. ALARM SYSTEM.

1. Alarm events: Activation of a device in the alarm system shall be treated as an access control alarm event, calling camera presets, calling any associated cameras to the operator's alarm monitors and creating automatic intercom calls (if available). This action shall take place without any operator's intervention.
2. Status events: Status alarm conditions (faults or errors) shall be reported to the access control system with unique identifiers.
3. Graphic status: All alarm devices shall be represented with graphic icons in the graphic maps part of the access control system GUI. Alarm devices shall represent their status with a different color, red for "on alarm" condition, and green for "no alarm" condition in the graphic maps.

G. Different methods of integration are allowed between the access control system and the other systems. Integration methods are given different hierarchy as follows, relay integration is lowest hierarchy, serial line integration is considered medium hierarchy integration and API integration is considered high hierarchy integration. At a minimum integration between the different security system shall be provided with the integration method explained below. It is acceptable for the SSI to propose integration methods with higher hierarchy integration methods, but not with lower hierarchy methods. The requested integration methods with each system are as follows:

1. Access control system and DVRS API integration.
2. Access control system and CCTV system API integration.
3. Access control system and Intercom system API integration.
4. Access control and door entry system Relay integration
5. Access control and Alarm system API integration
6. Access control and Detention system Relay integration
7. Access control and Paging system Serial line integration or API.
8. Access control and AV system Serial line integration or API.

3.3 INSTALLATION PRACTICES

- A. General: The SSI shall follow all installation practices indicated in specification section 270010.
- B. Access control panels and multi-output power supplies shall be installed as to have in any cluster of panels no less than 2 spare ports (reader ports for access control) available per cluster of panels.
- C. All power supplies shall be monitored for AC failure. When power supply provides a form c relay with low battery signaling, this contact shall also be monitored. All AC fail and battery low alarms shall be monitored through individual alarm inputs. Series connections of multiple alarm points shall not be allowed.
- D. All buzzers inside card readers shall be wired as to function to alert users of different door status like (door held open alarm and door forced open alarm).

- E. All local alarms shall be wired with separate wires for the buzzer and for the strobe, so independent use of the strobe and buzzer can be selected by the user.

3.4 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- E. All cable with gauges larger or equal to AWG-18 and all types of stranded conductors shall be terminated on termination blocks part of an active equipment or in termination blocks supplied by the SSI. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- F. All termination blocks shall always be mount inside a security enclosure, with a hinged cover and lock. Up to 2 conductors can be terminated in the same point in a termination block as long as the combined diameter of the conductors does not exceed the maximum cable diameter allowed by the termination block. No more than 2 conductors shall be terminated in the same point at a termination block regardless of the cable gauges.
- G. Termination blocks shall be used for wire terminations next to access control panels or for termination above the security doors. Termination blocks are not required for connection to security devices at the door side.
- H. When equipment supplied has wire leads instead of termination en points for connections, the only acceptable methods of connection to field wiring are insulated butt splices, quick release connectors (both ends provided) or quick lock self stripping pig tail connectors. All connectors or splices shall be selected according to the gauge of the cable to be terminated.
- I. All penetrations through fire rated barriers shall be provided, by the SSI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- J. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.
- K. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY-Raps" (Thomas & Betts or equal).

- L. All cables run part of the security system in areas where ceiling is not accessible or in building exterior shall be in conduit at all times.
- M. All cables for security equipment shall be installed in conduit to the nearest accessible ceiling space, J-hook to the cable tray and from the cable tray and from the tray to the equipment cabinets. The SSI shall provide all j-hooks to support the cables part of these components.
- N. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.
- O. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.
- P. Finger duct wire managers shall be used inside all equipment panels to properly dress cables.

3.5 IDENTIFICATION AND TAGGING

- A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.
- B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the SSI shall be submitted for approval to the A&E.
- C. All access control panels, alarm panels, PLCs, or Intercom exchanges shall include a work sheet attached to the interior of the panel/ equipment in plastic envelopes. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

3.6 SECURITY SYSTEM PROGRAMMING

- A. Programming: It is the responsibility of the SSI to program all requested features in the access control system and the integration to other security systems. The programming responsibilities of the SSI include but not limited to:
 - 1. Program all security doors to achieve the desired operation as described in this specification section. The SSI shall coordinate with the owner the door names and numbers, building names, room names and numbers to be used for the programming.
 - 2. Program all components of the system to achieve the functionality described in this specification.
 - 3. Program at least 5 access profiles for card holders and all access profiles for doors.
 - 4. Create at least 5 administrator profiles. The owner will program any additional card holder profiles required in the system.
 - 5. Program at least twenty five (25) users in the system. The SSI shall get this information from the owner. The owner will program all other users in the system.
 - 6. Program all required security features like macros and integration with other security modules like intercom and CCTV system.

7. Program all interfaces with the elevator control systems.
 8. Program all GUIs in the system. The SSI shall use Autocad drawings to create all maps of the facility with the corresponding icons for control, operation and visualization of the security system. The SSI shall chose a scale for the drawings that allows all icons to be places without overlap and close enough to the actual physical location of the equipment in the map as to avoid ambiguity of the actual location of the devices. Nested maps shall be programmed to go from a complete building view to a detail zoned identifying all devices in the area.
 9. The SSI shall coordinate with the owner what alarms from the access control system are to be considered major alarms. All major alarms shall be programmed by the SSI to provide the operator detail information on the type of operating procedure expected during those alarms. All mayor alarms shall be programmed as to provide the operator and input field to type the response taken by the operator.
 10. All programming of remote monitoring features for the security system like telephone numbers to dial, reporting codes and alarm formats.
 11. All alarm messages and descriptive text of those messages shall be programmed.
- B. DOOR INTERLOCKS: When indicated in the drawings (or in the sally port) two doors that have a controlled door interlocks, the SSI shall program the security system as to provide the following functionality: While one door is opened the other door shall not be possible to be opened not by using a valid transaction at the reader neither by issuing a remote release command from the access control system.
- C. The SSI shall work with the owner during the programming of the system to fine tune all programming requirements of the system, as per owner's request. Fine tune is defined for this purpose as changing all field parameters available in the system, as specified, to complete software options available in the system. Fine tuning does not indicate adding additional software modules or additional hardware.

3.7 ADDITIONAL INSTALLER RESPONSIBILITIES

- A. Upon project commencement, the SSI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- B. During the installation process the SSI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
1. Quantity and location of all equipment installed.
 2. Cable and wire runs along with the designations tags assigned to each.
 3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- C. The SSI Project Manager shall maintain continuous coordination with the A&E. The A&E shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the SSI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.8 REQUEST OF IP ADDRESSES

- A. The SSI shall comply with all requirements indicated in specification section 270010 for requesting IP address for the security system.

3.9 SYSTEM WARRANTY AND SERVICE

- A. General: The SSI shall follow all warranty and service requirements indicated in specification section 270010.

3.10 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The SSI shall follow all test requirements indicated in specification section 270010.
- B. Additional requirements for the system acceptance test:
 - 1. The day of the final acceptance test the SSI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
 - 2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
 - 3. During the final acceptance test every single device in the security system will be tested for normal operation and for simulated alarm conditions at both ends (the field devices and in the monitoring room). When possible, security equipment will be tested for operation during main power failure. All features requested in this specification will be tested.
- C. Testing of all structured cabling system part of the Security System shall be done in accordance of specification section 271000

3.11 SPARE PARTS

- A. As part of this project the SSI shall provide the following spare parts:
 - 1. One (1) Intelligent System ISC (ISC)
 - 2. One (1) Standard card readers
 - 3. One (1) Card reader with a keypad
 - 4. Two (2%) percent of all installed field devices, like local alarms, duress buttons, door position switches, tamper switches, request to exit motion sensors, etc.
 - 5. One (1) Power supply for locks
 - 6. One (1) power supplies for access control panels.
 - 7. Four (4) surge protection devices of each type used in the project.
- B. A list of delivered spare parts shall be included with the close out information. This list shall indicate all components delivered and shall be signed received by the Owner. The name of person receiving the equipment shall be clearly written in the list and the date it was received.

3.12 TRAINING AND INSTRUCTION

- A. General: The SSI shall follow all training requirements indicated in specification section 270010.
- B. The SSI shall provide three (3) levels of training for this project as explained in this section.
- C. USER TRAINING.
 - 1. User training shall be provided for security personnel interacting with the security system in areas different from the security monitoring rooms. The purpose of this training is to explain clearly how the field devices operate and what the different status indicators mean.
 - 2. This training shall cover operation of devices and doors like:
 - a. Operation and indication of all types of readers in the project
 - b. Operation of all roll-up doors.
 - c. Operation of all vehicular gates.
 - d. Resetting door alarms (local) for all door types.
 - e. Resetting of duress alarm buttons.
 - f. Operation of door interlocks
 - g. Operation of the duress alarm notification system
 - 3. This training shall be provided by personnel working directly for the SSI.
 - 4. At least 4 separate sessions (on 4 different days) of this type of training shall be provided (one session video-taped only).
 - 5. Each session could have up to 20 trainees.
 - 6. No training material is expected to be provided
- D. OPERATOR/ADMINISTRATION TRAINING.
 - 1. Operator/Administration training shall be provided for security and IT personnel interacting with the security system in all security monitoring rooms. The purpose of this training is to explain clearly how the complete system operates and what the different status indicators mean.
 - 2. This training shall cover at least the following topics:
 - a. All content provided during the user training.
 - b. Operation of the Access control software (all aspects).
 - c. Operation of all devices inside the security monitoring room.
 - d. Alarm response and alarm reset in the security monitoring room
 - e. Data backup/restore and achieving.
 - f. File import/export.
 - g. Badging system operation (complete description)
 - h. Creating reports and print outs.
 - i. Basic system troubleshooting.
 - j. Creating users and password reset.
 - 3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
 - 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 24 hours, broken down into day sessions no longer than 6 hours each.
 - 5. Each session could have up to 20 trainees.
 - 6. The approved O&M manuals shall be available at the time of the training.
- E. MAINTENANCE TRAINING.

1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
2. This training shall cover at least the following topics:
 - a. Trouble shooting and replacement of all field devices.
 - b. Installation of all field panels and settings (jumpers, dip switches, etc).
 - c. Wire labeling system.
 - d. Software system installation and recover from system crashes.
 - e. Detail explanation on all physical keys used in security devices.
 - f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
 - g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project.
3. This training shall be provided by personnel working directly for the SSI or a direct employee of the manufacturer of the system.
4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into day sessions no longer than 6 hours each.
5. Each session could have up to 5 trainees.
6. The approved O&M manuals shall be available at the time of the training.

3.13 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

- A. General: The SSI shall follow all as built and close out information requirements indicated in specification section 270010
- B. Additional requirements for as-built documentation shall include:
 1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
 2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.
- C. Close out information shall also include:
 1. Two (2) digital backups of all configuration files and databases part of the security system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
 2. Testing reports for structured cabling system used for the Security system.

END OF SECTION 281000

SECTION 28 15 00 – WIRED SECURITY VOICE COMMUNICATIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The scope of work shall include furnishing all labor, materials, enclosures, wiring, equipment, and documentation required to provide a completely operational and working Security Voice Communication System (SVCS).
- B. Security voice communication system covers devices and subsystems such as:
 - 1. Call stations,
 - 2. Intercom system (based on IP or proprietary communications lines) with audio and video or only audio.
 - 3. Door entry system
- C. The Security Voice Communication System Installer (SVCSI) shall coordinate with other trades such as security system, CCTV and electrical system installer, for all parts of this scope of work.
- D. All materials and installation labor for structured wiring system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair (25 pairs or higher) backbone cables) components required for the Security Voice Communication System shall be in compliance with specification section 27 10 00.
- E. All networking equipment (Ethernet switches and routers) required for the Security Voice Communication System will be provided by the Owner.
- F. All programming of the system is included in the scope of work as indicated in this specification section.

1.2 RELATED DOCUMENTS

- A. General Terms and Conditions of the Contract Documents
 - 1. Division 26 – Electrical
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.

SECTION	TITLE
27 00 10	Technology General Provisions
27 05 28	Raceways for Technology
27 10 00	Structured Cabling System
27 05 26	Grounding & Bonding for Telecommunications Systems
28 10 00	Electronic Security Systems
28 20 00	Closed Circuit Television System

1.3 SECURITY VOICE COMMUNICATION SYSTEM INSTALER QUALIFICATIONS

- A. The SVCSI selected for this project must be a direct manufacturer authorized representative of the product they propose to provide. All technicians assigned to install and configure this system shall be factory trained and certified for the proper installation of this equipment. The SVCSI must have a minimum of 5 qualified and factory trained technicians to support this system. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years under the current company name. This company shall have a fully staffed office of sales and technical support representatives within 100 miles of travel to this project.
- B. Other required SVCSI qualifications are:
 - 1. The SVCSI selected for this project must be an authorized reseller of the Zenitel intercom system.
 - 2. The SVCSI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The SVCSI shall be able to perform any and all repairs to the system within 24 hours.
 - 3. The SVCSI, as a minimum, must carry a current state issued limited energy license.

1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: See details for alternates and substitution in specification section 27 00 10
- B. Substitutions are acceptable for this system as long as the complete integration functionality described in this specification section with other systems is kept exactly as indicated in this specification.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The SVCSI shall follow all requirements for shop drawings indicated in specification section 27 00 10.
- B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 60 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the A&E for review and approval, as part of the product/installer approval process.
 - 1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
 - 2. Product numbers, specifications, and data sheets for all equipment.
 - 3. Data sheets and samples of all labeling materials and equipment to be used in the project.
 - 4. A complete explanation of the identification method to be used for all equipment and cabling part of the Security Voice Communication System.
 - 5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
 - 6. Detailed drawings of all custom products to be used in the project.
 - 7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.

- C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:
1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. All intercom substation and masters shall indicate the stations number in the system.
 2. Raceway Riser Diagrams: Detail raceway runs required for the SVCS and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run
 3. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination.
 4. Panel schedules in a spreadsheet format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all substations and masters.
 5. Termination details for multi-conductor connectors and other details not included in item 2 of the shop drawings.

1.6 ABBREVIATIONS

- A. The following abbreviations are used in this document:
1. ADA Americans with Disabilities Act
 2. ANSI American National Standards Institute
 3. API Application Programming Interface
 4. ASCII American Standard Code for Information Interchange
 5. AWG American Wire Gauge
 6. BPS Bits Per Second
 7. CCTV Closed Circuit Television
 8. CPU Central Processing Unit
 9. DIN (German Institute of Standardization)
 10. GUI Graphical User Interface
 11. ID Identification
 12. I/O Input /Output
 13. IP Internet protocol
 14. NEC National Electrical Code
 15. NEMA National Electrical Manufacturers Association
 16. ODBC Open Database Connectivity
 17. O&M Operations and Maintenance
 18. PABX Private Automatic Branch Exchange
 19. POE Power over Ethernet
 20. POTS Plain Old Telephone system, also known as a B1 interface, FXO or FXS
 21. RoHS Restriction of Hazardous Substances Directive
 22. SDRAM Synchronized Dynamic Random Access Memory
 23. SIP Session Initiation Protocol
 24. STP Shielded Twisted Pair
 25. UL Underwriters Laboratories, Inc.
 26. UPS Uninterrupted Power Supply
 27. USB Universal Serial Bus
 28. UTP Unshielded Twisted Pair
 29. VOC Volatile Organic Compounds
 30. VoIP Voice over IP

1.7 GLOSSARY OF TERMS

- A. The following terms are defined for the purposes of this specification:
1. Field Devices:

1.8 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. The SVCS primary purposes shall provide audio and video security communications between the field devices and the master stations of each system. The SVCS includes multiple systems that might not be interconnected together at all. The SVCS includes devices and systems such as:
1. Call stations. These devices are typically voice communications only and they operate based on a regular POTS line, an extension of a PABX (either through a POTS interface or a VoIP interface)
 2. Intercom systems. Intercom systems are typically voice and sometimes video communication devices that can work on multiple types of lines, with the following properties:
 - a. They have one or more exchanges, although they could be exchange-less (peer to peer) systems.
 - b. Work in either analog proprietary connections or Ethernet lines
 - c. Are composed of one or more master stations, substation or assistance stations.
 - d. Have the ability to integrate with other security systems, other SIP based communication system or have the ability to provide paging functions through a speaker system.
 3. Door entry system. This system is mostly a standalone system design to allow users to let people in through a security doors by being able to confirm with audible and visual communications the identity of the visitor. The system is typically an exchange-less (peer to peer) system with one or more master stations (receiving end) and one or more substations, also referenced as door stations. Typically the ability to open the door is done through a dry contact closure interface with the card access system or door lock.

PART 2 - SYSTEM CHARACTERISTICS

2.1 CALL STATIONS.

- A. The call station shall be a wall/pedestal mounted unit with a built in microphone speaker, capable of dialing a specific number once the button is pressed and hands-free half duplex communications. The call station does not require video camera included. The specifications of the unit are:
1. Unit communication interface: POTS line [Ethernet VoIP]
 2. Faceplate: 14 gauge brushed stainless steel with permanent laser etched graphics.
 3. Quantity of buttons: one [12 key keypad plus call button]
 4. Automatic Noise cancelation circuit: required
 5. Memory: unit shall have a non-volatile memory to store all the numbers that need to be called from this unit when a button is pressed.
 6. LED indicator: off the hook.
 7. Contact closure for remote door release: required. If the unit has the option to provide the contact closure separate from the unit, such option shall be provided.

8. Water resistivity rating: IP66
- B. Approved manufacturers: Viking Electronics Inc, Talkaphone Inc.
- C. Accessories: Outdoor units shall be provided with a rain hood. Unit shall be provided with advance door controller.

2.2 ASSISTANCE STATIONS.

- A. The assistance station shall be a wall mounted unit with a built in microphone speaker, capable of dialing a specific number once the button is pressed and hands-free half duplex communications. The specifications of the unit are:
 1. Unit communication interface: POTS line [Ethernet VoIP]
 2. Faceplate: brushed stainless steel with permanent laser etched graphics.
 3. Quantity of buttons: one [two]
 4. Automatic Noise cancelation circuit: required
 5. Button lettering type: ADA compliant size letters with braille text.
 6. Button marking: "Emergency" [and "Info"]
 7. Button colors: red [and black]
 8. Buttons specifications:
 - a. The switch shall be mechanically rated to 50,000 cycles (typical).
 - b. Provide tactile feedback
 9. Memory: unit shall have a non-volatile memory to store all the numbers that need to be called from this unit when a button is pressed.
 10. LED indicators: Two, to indicate unit is calling and second unit to indicate call has been answered.
 11. Contact closure: required.
 12. Water resistivity rating: IP66 or IP67
 13. Product approvals: FCC (47 C.F.R. Part 15, Subpart B)
 14. Safety testing: UL 60950-1
 15. Remote polling: unit shall have the ability to be polled by the main unit to be able to verify operation.
- B. The receiving end for the assistance station units shall be:
 1. A PABX system
 2. An intercom exchanged. See intercom system specifications.
 3. A stand-alone command control unit with 8 [16] [24] channels.
- C. Approved Manufacturers: Talkaphone Inc., Code Blue Corporation, Zenitel and Aiphone
- D. Accessories: The assistance station shall have the following accessories available:
 1. 16 Ga. Stainless steel surface mounted back box, vandal resistant, with signage letters.
 2. A wall mounted station composed of a stainless steel housing for the assistance station and a blue light. The housing shall have the word "Emergency" engraved. The light shall be a flashing LED blue light with an impact and UV resistant polycarbonate lens, powered through 12 or 24 VDC class 2 power supply.
- E. Product configurations:
 1. Type 1: Wall mounted station with housing and blue light.

2.3 INTERCOM SYSTEM.

- A. GENERAL. The intercom system is a two way audio communications system with or without the possibility of video. The system is composed of elements such as master stations, substations, in some cases with exchange units and accessories.
- B. SYSTEM CONFIGURATION. For this project in particular the configuration of the intercom system shall be:
 - 1. A peer-to peer communication between stations without the need of an exchange.
 - 2. An exchange based communication with all devices controlled and monitored by the exchange.
- C. INTERCOM MASTER STATIONS. The master station shall be half duplex or full duplex audio and video communication device unit with the following specifications:
 - 1. Description: desk/wall mounted, video unit with a handset.
 - 2. Communications interface: Ethernet VoIP SIP compliant
 - 3. Display: Backlit display, 35 x 68 (64 x 128 pixels)
 - 4. Power: PoE IEEE 802.3a-f.
 - 5. Audio codec: G.711, G.722 or G.729.
 - 6. Basis of design: Zenitel 1008001000
 - 7. Product configuration:
 - a. Type 3: surface wall mounted unit with handset.
 - b. Type 4: desk mounted unit with handset.
- D. INTERCOM SUBSTATION (audio only IP and SIP). The intercom substation shall be a wall mounted unit with built in speaker and microphone to provide half duplex or full duplex communications. The specifications of the intercom substation with IP/SIP are:
 - 1. SPL: rated power at 1m 90 dB
 - 2. Noise cancelling - suppression of musical noise: YES
 - 3. Noise cancelling - suppression of static noise: YES
 - 4. Codecs: G.711, G.722, G.729
 - 5. Frequency range: G.722 Codec 200 Hz – 7000 Hz
 - 6. Audio technology Modes: Full open duplex, switched open duplex,
 - 7. Automatic gain control (microphone)
 - 8. Internal speaker amplifier Class D
 - 9. Microphone technology Digital MEMS, omnidirectional microphone
 - 10. Automatic Volume Control (AVC) Undistorted and clear audio
 - 11. Acoustic Echo Cancellation (AEC) Prevents audio feedback even at high volumes (95dB)
 - 12. Speaker: Matches 10W amp for distortion-free broadcast level sound
 - 13. Ethernet connector 1 x RJ45
 - 14. General inputs and outputs 6 (configurable)
 - 15. Power options PoE and or external power supply
 - 16. PoE (power over Ethernet) IEEE 802.3af standard, Class 0 (0.44W to 12.95 W)
 - 17. Audio line out / Induction loop signal 0 dBu / 600 Ohm
 - 18. Button backlight LED
 - 19. Call indication Icons/colors for hearing impaired
 - 20. Basis of design: Zenitel TMIS-1
 - 21. Product configuration:
 - a. Type 3: Intercom substation, audio only IP and SIP

- E. INTERCOM EXCHANGE. The intercom exchange is purpose specific hardware design to monitor, route and control communications to SIP master stations, substations and provide connectivity to analog substations. The unit also provides the interface to the integration with other security system such as card access and CCTV. The specifications of the exchange are:
 - 1. Installed capacity: 552 IP stations
 - 2. Processor Subsystem NXP LS1043
 - 3. Storage Subsystem Solid state (1048 MB Flash)
 - 4. Memory 1048 MB SDRAM,
 - 5. Basis of design: Zenitel AlphaCom ICX-500
- F. ACCESSORIES. The following accessories shall be provided with the intercom system:
 - 1. Each intercom exchange shall be provided with a license for the configuring software. Bases of design: Zenitel AlphaPro Professional
 - 2. A Power supply for the exchange, as well as the rack shelf.
 - 3. IP page adapters in quantities as indicated in the design drawings. Basis of design Zenitel TKIE-2
 - 4. Software licenses to be provided:
 - a. IP station license for each station (master and substation) in th system.
 - b. Alphanet, 2 lines license.
 - c. SIP trunking, 4 lines license.

2.4 DOOR ENTRY SYSTEM.

- A. The door entry system is a standalone peer to peer audio and video communication system connecting users at a building entry point from an intercom substation to one or multiple intercom master stations inside the building. The intercom master stations shall be capable of releasing the door locks. The system is composed of intercom mater stations, the intercom substations and system accessories.
- B. INTERCOM MASTER STATION. The master station shall be half duplex or full duplex audio and video communication device unit with the following specifications:
 - 1. Communications interface: Ethernet VoIP SIP compliant
 - 2. Power source: PoE (IEEE 802.3af class 0)
 - 3. User interface: 7" TFT color LCD touchscreen, home and reset button.
 - 4. Audio input device: built in microphone
 - 5. Audio output device: speaker.
 - 6. Camera: built-in 1/3" CMOS 720p fixed unit, Onvif profile S compliant with privacy mask.
 - 7. Video codec: H.264/AVC, motion JPEG
 - 8. Audio codec: G.711.
 - 9. Listing: UL 62368-1
 - 10. Basis of design: Aiphone IX-MV7 series
 - 11. Product configurations:
 - a. Type 1 master station: flush mounted wall mounted unit – no handset
 - b. Type 2 master station: desk mounted unit with handset.
- C. INTERCOM SUBSTATION. The intercom substation, also referenced as door station, is a wall mounted with a built in camera, speaker and microphone to provide half duplex or full duplex communications. The specifications of the intercom substation are:
 - 1. Communications interface: Ethernet VoIP SIP compliant

2. Power source: PoE (IEEE 802.3af class 0)
3. User interface: One or more push buttons.
4. Audio input device: built in microphone
5. Audio output device: speaker.
6. Faceplate: Stainless steel, flush mounted unit IP65 rated.
7. Camera: built-in 1.23 megapixel with vertical adjustment unit, Onvif profile S compliant.
8. Video codec: H.264/AVC, motion JPEG
9. Audio codec: G.711.
10. Listing: UL 62368-1
11. Output ports: 2 dry contact outputs.
12. Basis of design: Aiphone IX-DVF series
13. Product configurations:
 - a. Type 1 master station: flush mounted wall mounted unit with 1 button
 - b. Type 2 master station: flush mounted wall mounted unit with 4 buttons.

- D. ACCESSORIES. Each door entry system shall be provided with a multi-purpose adapter with inputs and outputs as well as having the ability to provide access to the door entry system to mobile users. Basis of design: Aiphone IXW-MA.

2.5 SURGE PROTECTION

- A. All security components mounted outside the building and wired through low voltage copper conductor back to the building shall be provided with surge and lightning protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For network connections provide the CAT6-POE series surge suppressors, with C6-MP4 mounting bracket, manufactured by EDCO or an approved equal.

2.6 WIRE & CABLE

- A. Cables for low voltage power supplies shall have the following specifications:
1. Minimum cable gauge: AWG 18
 2. Number of conductors: 2, stranded conductors
 3. Conductor type: Bare copper
 4. Cable insulation: PVC
 5. Conductor insulation colors: Black and red.
 6. Voltage rating: 300V
 7. Cable shield: No cable shields
- B. All UTP Category horizontal cables and fiber optic cables for the security system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000.
- C. Cable gauge: All cable gauges for power supply cables shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The SVCSI shall always estimate proper values.

- D. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits. All spaces in this project shall be treated as plenum [non plenum] spaces.
- E. All cables shall be RoHS compliant and free of VOC. The SVCSI shall provide proof of compliance for all cables during the submittal process.
- F. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.7 IDENTIFICATION AND LABELING TAGS

- A. The SVCSI shall follow labeling materials indicated in specification section 27 00 10.

PART 3 - EXECUTION

3.1 SECURITY VOICE COMMUNICATION SYSTEM FUNCTIONALITY

- A. The purpose of the Security Voice Communication System is to provide voice communications with or without video communications.
- B. The SVCSI shall program and install the system based on the Owner's Security Policy and Procedures Handbook. The SVCSI shall coordinate with Owner all aspects of the installation of this system.

3.2 INSTALLATION PRACTICES

- A. General: The SVCSI shall follow all installation practices indicated in specification section 27 00 10.

3.3 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.

- E. When equipment supplied has wire leads instead of termination en points for connections, the only acceptable methods of connection to field wiring are insulated butt splices, quick release connectors (both ends provided) or quick lock self stripping pig tail connectors. All connectors or splices shall be selected according to the gauge of the cable to be terminated.
- F. All penetrations through fire rated barriers shall be provided, by the SVCSI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- G. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.
- H. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY-Raps" (Thomas & Betts or equal).
- I. See specification section 270528 for details on how the cabling for this system shall be installed.
- J. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.
- K. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.

3.4 IDENTIFICATION AND TAGGING

- A. The SVCSI r shall follow labeling materials indicated in specification section 270010 17010.
- B. All cables shall be labeled at both ends of the cable with the same and unique identifier label.
- C. Cable and equipment identifiers shall follow a standard labeling system like TIA 606. The identification system chosen by the SVCSI shall be submitted for approval to the A&E.

3.5 SECURITY VOICE COMMUNICATION SYSTEM PROGRAMMING

- A. SCOPE: It is the responsibility of the SVCSI to program all requested features in the SVCS and the integration to other security system. The programming responsibilities of the SVCSI include but not limited to:
 - 1. Program all components of the system to achieve the functionality described in this specification.
 - 2. Program all required security features such as integration with card access systems and CCTV system.
- B. NUMBER DIALING. The SVCSI shall program all calling numbers for the call stations and/or assistance stations.

- C. SIP INTEGRATION. For call stations, assistance stations, intercom and door entry systems that are part of a VoIP PABX system, the SVCSI [the owner] shall program the PABX system to integrate the call/assistance stations and shall provide the SIP licenses for the PABX system.
- D. NETWORK INTEGRATION. The SVCSI shall program the intercom exchange to be integrated into the owner's Zenitel Alphanet network as another node.

3.6 ADDITIONAL INSTALLER RESPONSIBILITIES

- A. Upon project commencement, the SVCSI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- B. During the installation process the SVCSI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
 - 1. Quantity and location of all equipment installed.
 - 2. Cable and wire runs along with the designations tags assigned to each.
 - 3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- C. The SVCSI Project Manager shall maintain continuous coordination with the A&E. The A&E shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the SVCSI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.7 REQUEST OF IP ADDRESSES

- A. The SVCSI shall comply with all requirements indicated in specification section 27 00 10 for requesting IP address for the Security Voice Communication System.

3.8 SYSTEM WARRANTY AND SERVICE

- A. General: The SVCSI shall follow all warranty and service requirements indicated in specification section 27 00 10.

3.9 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The SVCSI shall follow all test requirements indicated in specification section 27 00 10.
- B. Additional requirements for the system acceptance test:
 - 1. The day of the final acceptance test the SVCSI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test

- substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
 - 2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SVCSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
- C. Testing of all structured cabling system part of the SVCS shall be done in accordance of specification section 27 10 00.

3.10 SPARE PARTS

- A. As part of this project the SVCSI shall provide the following spare parts:
 - 1. Two (2%) percent of all installed field devices.
 - 2. Two (2) surge protection devices of each type used in the project.
- B. A list of delivered spare parts shall be included with the close out information. This list shall indicate all components delivered and shall be signed received by the Owner. The name of person receiving the equipment shall be clearly written in the list and the date it was received.

3.11 TRAINING AND INSTRUCTION

- A. General: The SVCSI shall follow all training requirements indicated in specification section 27 00 10.
- B. The SVCSI shall provide one (1) levels of training for this project as explained in this section.
- C. MAINTENANCE TRAINING.
 - 1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
 - 2. This training shall cover at least the following topics:
 - a. Trouble shooting and replacement of all field devices.
 - b. Installation of all field devices and settings (jumpers, dip switches, etc).
 - c. Wire labeling system.
 - d. Software system installation and recover from system crashes.
 - e. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
 - 3. This training shall be provided by personnel working directly for the SVCSI or a direct employee of the manufacturer of the system.
 - 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 8 hours, broken down into three day sessions no longer than 4 hours each.
 - 5. Each session could have up to 5 trainees.
 - 6. The approved O&M manuals shall be available at the time of the training.

3.12 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION.

- A. General: The SVCSI shall follow all as built and close out information requirements indicated in specification section 27 00 10.
- B. Additional requirements for as-built documentation shall include:
 - 1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
 - 2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.
- C. Close out information shall also include:
 - 1. Testing reports for structured cabling system used for the Security system.

END OF SECTION 281010

SECTION 282000 CLOSED CIRCUIT TELEVISION/VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The scope of work shall include furnishing all labor, all security video cameras, mounts, housings, power supply systems, cabling, connectors and head end components, including all other hardware and software and documentation required to provide a completely operational and working Closed Circuit Television (CCTV) System.
- B. All materials for the structured cabling system (4-pair UTP cables, fiber optic cables and 24-AWG multi-pair 25 pairs or higher) components required for the video surveillance system shall be in compliance with specification Section 271000.
- C. The following parts of the system are not part of this contract:
 - 1. All networking equipment (switches, routers, etc) for the operation of the system
 - 2. All computers and software to run the security system with the exception of the items indicated in this specification.
 - 3. Software licenses for the video surveillance system beyond the 12 months included in this contract.

1.2 RELATED DOCUMENTS

- A. General Terms and Conditions of the Contract Documents
 - 1. Division 16 – Electrical
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
 - 1. 270010 Technology General Provisions
 - 2. 270528 Raceways for Technology
 - 3. 271000 Structured Cabling System
 - 4. 270526 Ground and Bonding for Communications Systems
 - 5. 281000 Electronic Security System

1.3 CCTV INSTALLER QUALIFICATIONS

- A. The Video Surveillance or CCTV installer (CI) selected for this project must be a direct representative of the products they intent to provide. All technicians assigned to install and configure this system shall be factory trained. This company must be of established reputation and experience, regularly engaged in the supply and support of such systems for a period of at least five consecutive years under the current company name. This company shall have a fully staffed office of sales and technical support representatives within 100 miles of this project.
- B. Other required CI qualifications are:

1. The CI shall agree, in writing, as part of their proposal, to provide both warranty and non-warranty service within 4 hours of notification of a problem. The CI shall be able to perform any and all repairs to the system within 24 hours.
2. The CI, as a minimum, must carry a current state issued limited energy license.
3. The CI shall have staff trained in programming the CCTV system as described in this specification. The CI shall submit as part of the qualifications required, the resume of the programmers for the CCTV system as well as the training certificates for this staff from the manufacturer of the system.

1.4 MATERIALS ALTERNATES AND SUBSTITUTION

- A. General: See details for alternates and substitution in specification section 270010
- B. Due to compatibility issues with other buildings under the control of the owner, the only approved Digital Video Management System (DVMS) to be provided in this project is XXXXXXXXXXXXXXXX. No substitutions are accepted for this type of equipment.
- C. Cameras can be substituted as long as they have the same performance specification as the cameras used as basis of design and as long as they are supported by the DVMS. It is the responsibility of the CI to verify and assure the cameras proposed as substitution are supported by the DVMS. Any cost associated with certifying a proposed camera to the DVMS to be used in this project shall be covered by the CI.

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. The CI shall follow all requirements for shop drawings indicated in specification section 270010
- B. The submittal process for this scope of work will be a two stage process. The first stage is the product/installer approval. Within 30 business days of receiving contract approval and notice to proceed, the following items shall be submitted to the Architect and Engineer (A&E) of the project for review, as part of the product/installer approval process.
 1. Proof of Installer qualifications, addressing all requirements of paragraph 1.3 of this specification.
 2. Product numbers, specifications, and data sheets for all equipment.
 3. Data sheets and samples of all labeling materials and equipment to be used in the project.
 4. A complete explanation of the identification method to be used for all equipment and cabling part of the CCTV system.
 5. Data sheets of all termination blocks and mounting accessories to be used in the project. A paragraph shall be added before each data sheet indicating the intended use of each type of termination block.
 6. Detailed drawings of all custom products to be used in the project.
 7. Data sheets for all wire and cable to be used as part of this system. A paragraph shall be added before each data sheet indicating the intended use (to connect what type of devices) of each cable.
- C. The second stage of the submittal process is the shop drawing process. Shop drawings shall only be submitted after all portions of the product/installer approval have been accepted by the A&E. The following information is required as part of the shop drawings:

1. Floor plans indication all devices to be provided and all cable runs to all devices or junction boxes. All cameras shall indicate the camera number in the system and the type of camera and mounting.
2. Point to point wiring diagrams indicating all termination points for each conductor and for each device, cable types and color coding of each termination. These diagrams shall be submitted for each camera type.
3. Storage calculation. The CI shall provide a spreadsheet with all the cameras in the project and the proposed recording frame rates, resolutions, activity percentages and times of recording with the total number of storage bytes per camera and a total for the system. The total storage capacity shall be indicated in Terabytes.
4. Bandwidth calculation. The CI shall provide a network bandwidth calculation for the system. This calculation shall be presented in the form of a spreadsheet using MBPS as the units listing all cameras in the project. The spreadsheet shall have subtotals per network region associated with a storage area.
5. Completely fill out network configuration template provided by TLC Engineering upon request, to explain all network devices to be used in a project and to get IP addresses from the network administrator.
6. Video recording server assignment. A list of all the video servers to be provided in the project with a list of all cameras assigned to each server. Each server shall have a total bit rate estimated for all the cameras recorded showing that the capacity requirements of the server comply with the requirements in this specification.
7. Panel schedules in a table format, indicating all ports being used and what device is connected to each port. Panel schedules shall be submitted for all camera power supply, multiport encoder/decoders, computer monitor outputs, fiber optics distribution frames, Ethernet switches, patch panels, termination blocks, etc.
8. Overall system diagrams indicating all head end components, their room location, and all configuration characteristics like IP addresses, serial ports used, etc.
9. A field of view study. This field of view is a collection of still pictures with the precise field of view for each camera to be installed in the project. The field of view shall be the same coverage as the camera specified and will be used to verify installation of the cameras and during acceptance test.
10. Outline of the testing process.

1.6 ABBREVIATIONS

- A. The following abbreviations are used in this document:
1. API - Application Programming Interface
 2. ASCII - American Standard Code for Information Interchange
 3. BPS - Bits Per Second
 4. CIF - Common Intermediate Format (352 X 240)
 5. 2CIF - Common Intermediate Format (704 X 240)
 6. 4CIF - Common Intermediate Format (704 X 480)
 7. DVI - Digital Visual Interface
 8. FCC - Federal Communications Commission
 9. GUI - Graphical User Interface
 10. HDMI - High Definition Multimedia Interface
 11. ID - Identification
 12. I/O - Input /Output
 13. IPS - Images Per Second
 14. MBPS - Mega Bits per Second

15. NTP - Network Time Protocol
16. NTSC - National Television Standard Committee
17. ODBC - Open Database Connectivity
18. ONVIF - Open Network Video Interface Forum
19. O&M - Operations and Maintenance
20. PAL - Phase Alternating Line
21. PIN - Personal Identification Number
22. PTZ - Pan/Tilt/Zoom
23. RAID - Redundant Array of Independent Disks
24. RoHS - Restriction of Hazardous Substances Directive
25. SDRAM - Synchronized Dynamic Random Access Memory
26. STP - Shielded Twisted Pair
27. TCP/IP - Transmission Control Protocol/Internet Protocol
28. UL - Underwriters Laboratories, Inc.
29. UPS - Uninterrupted Power Supply
30. USB - Universal Serial Bus
31. UTP - Unshielded Twisted Pair
32. VOC - Volatile Organic Compounds

1.7 SYSTEM DESCRIPTION

- A. The CCTV system shall be a TCP/IP network-based, fully distributed digital video system. The CCTV system will utilize local area networks (LAN) as a transmission medium for video, configuration, as well as storage of all data. The CCTV system shall provide full video control at the management point indicated in the design drawings, with additional full selection capability at any point within the network from a computer workstation. The CCTV system shall provide unlimited expansion capability for the addition or modification of any video device or computer workstation.
- B. The CCTV system shall permit normal and event monitoring of all secured areas on digital monitors as required or shown in the specifications and drawings. In all cases, the equipment shall be state of the art, standardized commercial off-the-shelf, and modular. In all cases, the method of communication from remote locations within the network to the central components shall be transparent to the user. Equipment shall be selected and installed so repairs may be accomplished on site by module replacement, utilizing spare components whenever possible.
- C. The intent of this specification is to provide the owner with a distributed networked digital security system. Supplied by the CI, the CCTV system shall be complete and operational per the performance requirements and objectives of these specifications. The CI shall be responsible for the coordination of related work with other trades affecting his/her work or the work of others.
- D. The CCTV System shall be fully integrated with other security components such as access control, alarm monitoring and intercom communications. The system shall be fully integrated with the access control application to allow events to be directly linked to the CCTV surveillance recording system. See specification section 281000 for details of the integration scope of work and the performance required.
- E. All cameras shall be connected and controlled through a CCTV workstation utilizing a standard mouse and keyboard.

PART 2 - PRODUCTS

2.1 DIGITAL VIDEO MANAGEMENT SYSTEM

- A. The digital video management system shall be composed of off the shelf management servers, storage system and the DVMS Software. The recording system shall be based on a Storage Array Network (SAN) configuration. The storage system shall be composed of DVMS management server, DVMS recording servers, storage arrays, and storage expansion units. The recording system shall be based on a unified NVR composed of a complete server, storage array, storage drives and expansion modules as required.
- B. The DVMS recording servers shall process all video streams for recording, live viewing, and playback for the cameras assigned to that recorder. Servers shall be provided in quantities as to not any single server being used at more than 75% of the maximum bit rate capacity of the server. Quantities of servers indicated in the drawings are preliminary and the CI shall provide calculations to the A&E of the final quantity of servers to be provided.
- C. The SAN storage arrays and storage expansion shall provide a network attached storage medium for the video servers.
- D. The drawings provide a total video storage capacity of 140 TB. This has been determined to be the required RAID-5 storage with all cameras recorded at max resolution, and with frame rates as indicated in paragraph 3.5 for a total of 30 days. It shall be the responsibility of the CI to provide the correct amount of storage based on the camera resolutions indicated on the drawings recording at the parameters provide, but no less than the 140 TB indicated previously.

2.2 DIGITAL VIDEO MANAGEMENT SYSTEM SOFTWARE

- A. The CI shall provide all software required for the complete operation of the video surveillance system.
- B. The approved products for this system are:
 - 1. Lenel – OnGuard Video
 - 2. American Dynamics – VideoEdge
 - 3. Qognify – Ocularis or VideoHub
 - 4. Genetec – Omnicast
 - 5. Pelco - VideoExpert
 - 6. Bosch - BVMS
 - 7. Kantech Systems – Intevo
 - 8. Honeywell – Pro-Watch, MaxPro-VMS
 - 9. Panasonic – Video Insight
- C. Other digital video management software can be accepted prior approval of the A&E.
- D. At a minimum the video surveillance system software shall provide the following key features:
 - 1. Ability to see live video and recorded video in the same application software.
 - 2. Ability to export video to an open standard file like AVI files
 - 3. Ability to integrate with other system with features as indicated in this specification.
 - 4. Support browser based clients and standard client workstation.

5. Have video analytics incorporated into the DVMS.

2.3 DVMS MANAGEMENT SERVER

- A. The DVMS management server shall have the following specifications:
 1. Processor: Two (2) Eight Core Processors, at 2.0GHz CPU, Energy Smart
 2. Front side bus: 1333 MHz
 3. Cache: 4 MB Level 2 / 12 MB Level 3
 4. Memory: 32 GB DDR3-1333MHz, Energy Smart
 5. Graphics card: SVGA Graphic Card (with VGA connector)
 6. Hard drive configuration: Integrated SAS/SATA Raid 6
 7. Back plane: 1X8 bay for 2.5" hard drives
 8. Hard drives: Four (4) 73GB 15,000 RPM SAS SCSI 3Gbps 2.5" HotPlug hard drives
 9. CD/DVD Drive: 24x CD-RW/DVD Rom Drive SATA, internal
 10. Network Card: Dual 10/100/1000 Base-T
 11. Power supply: Energy Smart redundant power supply with dual cords. NEMA 5-15p 15A 10 ft. cords.
 12. USB ports: Minimum six (6) USB 2.0
 13. Serial ports: Minimum one (1) RS-232 in DB-9 connector.
 14. Options: USB to PS2 adapter for KVM connectivity
 15. Mounting: Rack chassis with sliding rapid/versa rails and cable management arm.
 16. Operating system: Windows 200X Server as recommended by Nice Systems, with software licenses to connect all workstations and cameras in the project plus 2 spare licenses for workstations and 10 spare licenses for cameras.
 17. Warranty: 3 –year warranty.
 18. Design Selection: Dell or HP.

2.4 CCTV WORKSTATION

- A. The rack mounted CCTV Workstations shall be a certified industry standard computer in a rack configuration. It must meet all requirements established by the DVMS software manufacturer. As a minimum the system capacity shall be as follows:
 1. Processor: Two (2) Six Core Xeon Processors at 3.46 Ghz CPU
 2. Front side bus: 1333 MHz
 3. Cache: 12MB
 4. Memory: 12GB SDRAM, 1333MHz, ECC
 5. Ports: 1 Parallel, 2 Serial (DB-9), 10 USB 2.0
 6. Graphics card: Two 4GB Graphics Cards SLI, with quad DVI outputs each
 7. Hard Drive: Three (3) in RAID 1 configuration 600GB SATA 10K RPM 3.0 Gb/s Hard Drive
 8. CD/DVD Drive: One (1) 16X DVD+/-RW SATA with DVD burning software and DVD player software.
 9. Network Card: 10/100/1000 Base-T
 10. Mounting: rack mounted
 11. Accessories: Standard USB keyboard and USB optical mouse.
 12. Operating system: Windows version as recommended by Lenel Systems.
 13. Other software: Anti-virus software included with one year license.
 14. Warranty: 3-years
 15. Design Selection: Dell Precision R5500 or equal on HP

- B. The desk mounted CCTV workstation shall be a supplier certified industry standard computer. It must meet all requirements established by the DVMS software manufacturer and shall have a recommended minimum system capacity as follows:
1. Processor: One (1) Intel i7 processor at 3.4 Ghz CPU
 2. Front side bus: 1333 MHz
 3. Cache: 8MB
 4. Memory: 8GB SDRAM, 1333 Hz
 5. Ports: 1 Serial (DB-9), 10 USB 2.0, 2-line in audio, 2 line out audio,
 6. Graphics card: 1GB Graphic Card, with dual DVI outputs with sound
 7. Speakers: Sound bar to be mounted under the flat panel display. External speakers desk mounted not acceptable.
 8. Hard Drive: 500GB SATA 6.0 Gb/s with 16MB DataBurst Cache Hard Drive
 9. CD/DVD Drive: One 8X Blu-ray Disc Burner with Blu-ray burning software and Blu-ray player software.
 10. Network Card: 10/100/1000 Base-T
 11. Power supply: 88% Efficient power supply
 12. Energy Efficiency: Energy Star 4.0 Category B, EPEAT gold
 13. Mounting: rack mounted, desk mounted, mini-tower or small form factor chassis as indicated in workstation list. For rack mounting, desk top units fitting a rack tray are acceptable. Mini-tower configurations on a shelf are not acceptable for rack mount.
 14. Accessories: Standard USB keyboard and USB optical mouse For rack mounted devices, USB to PS2 adapters are required.
 15. Operating system: Windows version as recommended by Lenel.
 16. Other software: Anti-virus software included with one year license.
 17. Warranty: 3-years
 18. Design Selection: Dell Optiplex 990 family or equal on HP.
- C. The CCTV workstations shall include monitors, converters, and extenders as indicated on the drawings.
- D. The CCTV workstation shall include the DVMS software included.

2.5 DVMS VIDEO SERVER

- A. The DVMS video server shall process the video streams from the IP cameras for recording on the storage array or viewing at workstation and decoder locations. A maximum of 36 cameras shall be programmed per server.
- B. The DVMS video server shall use commercial off the shelf server equipment with dual redundant hot swap power supplies. The server shall have a minimum of 12 GB RAM.
- C. The DVMS video server shall have Two 1 GbE ports for connection to the security network and Two 1 GbE iSCSI ports for connection to the iSCSI network switch.
- D. The DVMS video server shall be the Intransa VA35as-3 with the VA35as-12GB memory option or approved equal.

2.6 DVMS STORAGE ARRAY

- A. The DVMS storage array shall store all recorded video for the required amount of time. The storage array shall also provide the interface with up to three storage expansion units connected via JBOD cable.
- B. Total capacity of the storage array shall be 24 TB using 2TB SATA-II hot swap disk drives in a RAID 6 configuration.
- C. Each storage array shall have two 1GbE iSCSI ports for connection to the iSCSI network switch.
- D. Recording software installed shall be compatible and approved for use with the Lenel SkyPoint DVMS software and the manufacturer of the computer storage hardware.
- E. The DVMS storage array shall be the Intransa VA300st-24TB-1 or approved equal.

2.7 DVMS STORAGE EXPANSION

- A. The DMVS storage expansion shall allow an additional 24 TB of storage capacity. Each expansion unit shall connect to the DVMS storage array through a JBOD cable.
- B. Total capacity of the storage expansion shall be 24 TB using 2TB SATA-II hot swap disk drives in a RAID 6 configuration.
- C. The DVMS storage array shall be the Intransa VA300-EXPNDR-24TB-1 or approved equal.

2.8 KVM SLIDE TRAY

- A. Rack mount pull out monitor, keyboard, mouse, KVM switch shall allow all equipment requiring a computer type man machine interface to utilize a single point for control and viewing. All equipment shall connect to the KVM for control.

2.9 PTZ IP CAMERA

- A. The PTZ IP camera dome system shall include a built-in 100Base-TX network interface for live streaming to a standard Web browser.
- B. The PTZ IP dome camera dome system shall operate in an IP video system environment specified for this project and shall be controllable from that platform, as well as open architecture connectivity for third-party software recording solutions. The PTZ IP dome camera shall be an ONVIF compliant camera.
- C. The video imager of the PTZ IP camera meet or exceed the following design and performance specifications:
 - 1. Imager type: Progressive scan CMOS
 - 2. Maximum Resolution: As indicated in the design drawings.
 - 3. Frame rate: up to 50/60 frames per second @ maximum resolution.

4. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles, H.265 (MPEG-H Part 2/HEVC) Main Profile or Motion JPEG.
 5. Video streams: Multiple, individually configurable streams in H.264, H.265 and motion JPEG.
 6. Minimum illumination: Color: 0.15 lux at 50 IRE, F1.6 B/W: 0.003 lux at 50 IRE, F1.6
 7. Gain control: automatic
 8. Audio: Two way, full duplex audio with a 24 bit LPCM compression system.
- D. The lens of the PTZ IP camera meet or exceed the following design and performance specifications:
1. Focus: Automatic
 2. Iris: auto-iris
 3. Zoom: Optical zoom 40X [32X] [30X] and digital zoom of X12
- E. The dome drive for the PTZ IP camera system shall meet or exceed the following design and performance specifications:
1. Pan capabilities: 360° endless
 2. Tilt capabilities: 180° with auto-flip capabilities
 3. Pan/Tilt Speed: Variable between 450° per second continuous pan to 0.05° per second
 4. Additional PTZ drive features:
 - a. Preset positions: >100 positions.
 - b. Proportional Pan/Tilt Speed: Speed decreases in proportion to the increasing depth of zoom.
 - c. Tour recording (max 10, 16 minutes each)
 - d. Guard tour: max 100
- F. The PTZ IP camera shall have the following network security features and processing abilities:
1. Security features:
 - a. Password protection,
 - b. IP address filtering,
 - c. HTTPS encryption,
 - d. IEEE 802.1x (EAP-TLS) network access control
 - e. Digest authentication
 - f. User access log.
 - g. Centralized certificate management
 - h. Brute force delay protection
 2. Supported protocols: IPv4, IPv6 USGv6, HTTP, HTTPSa, SSL/TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP®, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SRTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, NTCIP, LLDP, MQTT,
 3. Analytics: included [not required]
 4. Included Analytics:
 - a. Video motion detection.
 - b. Tripp line alarms
 - c. Loitering behavior.
 - d. People auto-tracking
 - e. Audio detection
- G. The PTZ IP camera shall have the these other characteristics:
1. Housing: Metal (aluminum) casing for outdoor cameras and impact resistant polycarbonate housing for interiors

2. Lower dome: acrylic clear dome
3. Power: PoE or Separate 24VDC power connector.
4. Local storage: Supports SD/SDHC/SDXC cards [not required]
5. Operating temperature: 0 °C to 50 °C (32 °F to 122 °F)
6. Operating humidity: 10–85% RH (non-condensing)

H. Approved manufacturers: Axis, Pelco, Panasonic and Samsung.

I. Design selection: The CI shall select a camera that complies with the performance requirements indicated above from the approved manufacturer's list. [write specific part number].

2.10 FIXED IP DOME CAMERA

- A. The fixed IP dome camera for this project shall be an integrated camera and dome.
- B. The fixed IP dome camera shall include a built-in 100Base-TX network interface for live streaming to a standard Web browser.
- C. The fixed IP dome camera shall operate in an IP video system environment specified for this project and shall be controllable from that platform, as well as open architecture connectivity for third-party software recording solutions.
- D. The fixed IP dome camera shall meet or exceed the following design and performance specifications:
 1. Image sensor type: Progressive scan RGB CMOS
 2. Maximum imager resolution: As indicated in design drawings
 3. Frame rate: 30 fps at the maximum resolution possible in the camera.
 4. Video streaming: Multiple, individually configurable streams in H.264 and H.265
 5. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles and H.265 (MPEG-H Part 2/HEVC) Main Profile.
 6. Lens: Varifocal with an ability to provide a horizontal field of view from 50° to 90°
 7. Focus/zoom (back focus): Manual [motorized remote]
 8. Minimum illumination: 0.12 lux at 50 IRE
 9. Camera adjustment: manual pan adjustment 360° and tilt adjustment 80°
 10. Audio: Two way, full duplex audio with a 24 bit LPCM compression system.
 11. Audio input/output: Input for external microphone or line-level device, Line output with automatic gain control.
 12. Network security: Password protection, IP address filtering, IEEE 802.1X (EAP-TLS) network access control, HTTPS encryption, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware.
 13. Supported protocols: IPv4, IPv6, USGv6, HTTP, HTTPS, SSL/TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, SIP, LLDP, MQTT.
 14. Analytics: included [not required]
 15. Included Analytics:
 - a. Video motion detection.
 - b. Tripp line alarms
 - c. Loitering behavior.
 - d. Audio detection

16. Casing: Polycarbonate impact resistant (IK10 rated) and weather resistant IP52 (rated).
17. Lower dome: clear.
18. Power connection: PoE IEEE 802.3af/802.3at Type 1
19. IR illumination: required with a range up to a minimum of 100 ft. [not required]
20. Local storage: Supports SD/SDHC/SDXC cards [not required]
21. Operating temperature: 0° C to 50° C (32° F to 122°F)
22. Operating humidity: 10–95% RH (non-condensing)

- E. Approved manufacturers: Axis, Pelco, Panasonic and Samsung.
- F. Design selection: The CI shall select a camera that complies with the performance requirements indicated above from the approved manufacturer's list. [write specific part number].

2.11 PANORAMIC MULTI-IMAGER FIXED IP DOME CAMERA

- A. The panoramic multi-imager fixed IP dome camera for this project shall be an integrated camera and dome.
- B. The panoramic multi-imager fixed IP dome camera shall include only one built-in 100Base-TX network interface for live streaming to a standard Web browser.
- C. The panoramic multi-imager fixed IP dome camera shall operate in an IP video system environment specified for this project and shall be controllable from that platform, as well as open architecture connectivity for third-party software recording solutions.
- D. The panoramic multi-imager fixed IP dome camera shall meet or exceed the following design and performance specifications:
 1. Image sensor type: Three (3) or four (4) Progressive scan RGB CMOS
 2. Maximum imager resolution: As indicated in design drawings but no less than 3 MP per imager
 3. Frame rate: 30 fps at all resolutions.
 4. Video streaming: Multiple, individually configurable streams in H.264 and H2.265
 5. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles and H.265 (MPEG-H Part 2).
 6. Lens: Fixed focus or varifocal with the ability to provide 180° or 360° field of view, as indicated in the design drawings, with all the imagers.
 7. Minimum illumination: 0.3 lux at 50 IRE
 8. Audio: Two way, full duplex audio with a 24 bit LPCM compression system.
 9. Audio input/output: Input for external microphone or line-level device, Line output with automatic gain control.
 10. Network security: Password protection, IP address filtering, IEEE 802.1X (EAP-TLS) network access control a , HTTPSa encryption, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware.
 11. IP address: One IP address for all imagers.
 12. Supported protocols: IPv4, IPv6 USGv6, HTTP, HTTPS, SSL/TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP TM, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, SIP, LLDP, MQTT.
 13. Analytics: included [not required]
 14. Included Analytics:

- a. Video motion detection.
- b. Tripp line alarms
- c. Loitering behavior.
15. Casing: Polycarbonate impact resistant (IK9 rated or higher) and weather resistant IP66 (rated).
16. Lower dome: clear.
17. Power connection: PoE IEEE 802.3af/802.3at Type 1
18. IR illumination: one illuminator per imager required with a range up to a minimum of 50 ft. [not required]
19. Local storage: Supports SD/SDHC/SDXC cards [not required]
20. Operating temperature: 0 °C to 50 °C (32 °F to 122 °F)
21. Operating humidity: 10–95% RH (non-condensing)

E. Approved manufacturers: Axis, Pelco, Panasonic and Samsung.

F. Design selection: The CI shall select a camera that complies with the performance requirements indicated above from the approved manufacturer's list. [write specific part number].

2.12 PANORAMIC SINGLE IMAGER FIXED IP DOME CAMERA

- A. The panoramic single imager fixed IP dome camera for this project shall be an integrated camera and dome.
- B. The panoramic single imager fixed IP dome camera shall include only one built-in 100Base-TX network interface for live streaming to a standard Web browser.
- C. The panoramic single imager fixed IP dome camera shall operate in an IP video system environment specified for this project and shall be controllable from that platform, as well as open architecture connectivity for third-party software recording solutions.
- D. The panoramic single imager fixed IP dome camera shall meet or exceed the following design and performance specifications:
 1. Image sensor type: One (1) Progressive scan RGB CMOS
 2. Maximum imager resolution: 12 MP
 3. Frame rate: 30 fps at all resolutions.
 4. Video streaming: Multiple, individually configurable streams in H.264 and Motion JPEG
 5. Video compression: H.264 (MPEG-4 Part 10/AVC) Baseline, Main and High Profiles and Motion JPEG.
 6. Lens: Fixed focus, fixed iris with the ability to provide 180° in the vertical and horizontal directions.
 7. Minimum illumination: 0.19 lux at 50 IRE
 8. Audio: Two way, full duplex audio with a 24 bit LPCM compression system.
 9. Audio input/output: Input for external microphone or line-level device, Line output with automatic gain control.
 10. Network security: Password protection, IP address filtering, IEEE 802.1X (EAP-TLS) network access control, HTTPS encryption, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware.
 11. IP address: One IP address for all imagers.
 12. Supported protocols: IPv4, IPv6, USGv6, HTTP, HTTPS, SSL/TLSa, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, Bonjour, UPnP/TM, SNMP v1/v2c/v3 (MIB-

- II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH, SIP, LLDP, MQTT.
 - 13. Analytics: included [not required]
 - 14. Included Analytics:
 - a. Video motion detection.
 - b. Tripp line alarms
 - c. Loitering behavior.
 - 15. Casing: Polycarbonate impact resistant (IK10 rated) and weather resistant IP66 (rated).
 - 16. Lower dome: clear.
 - 17. Power connection: PoE IEEE 802.3af/802.3at Type 1
 - 18. IR illumination: one illuminator required with a range up to a minimum of 40 ft. [not required]
 - 19. Local storage: Supports SD/SDHC/SDXC cards [not required]
 - 20. Operating temperature: 0 °C to 50 °C (32 °F to 122 °F)
 - 21. Operating humidity: 10–95% RH (non-condensing)
 - 22. The DVMS used in the project shall have the de-warping software required to make the video image more usable.
- E. Approved manufacturers: Axis, Pelco, Panasonic and Samsung.
- F. Design selection: The CI shall select a camera that complies with the performance requirements indicated above from the approved manufacturer's list. [write specific part number].

2.13 CAMERA MOUNTS AND ADAPTERS

- A. All cameras shall be provided with the mounts and adapters as indicated in the floor types and mounting types indicated in part 3 of this specification. Each camera type indicated in the floor plans shall be matches to one camera type. Examples of mount and adapters include wall mount, trim rings, corner mounts, pole mounts, suspended pole mounts, etc.
- B. The CI shall choose the mounts based on the equipment being supported. All mounts shall be made by the same manufacturer of the cameras. Custom made mount are not acceptable, unless approved by the A&E.

2.14 FIBER OPTIC TRANSCEIVERS

- A. Fiber optic transceivers shall be used for all cameras with wiring distances that exceed 300 feet and cameras installed outdoors with direct exposure to the elements.
- B. Fiber optic transceivers shall be available for singlemode and multimode fiber optic cable.
- C. Field mounted transceivers shall be single port (RJ-45) and shall be capable of being installed inside a 12" x 12" junction box. The field mounted transceiver shall be the Comnet CNFE100 series or approved equal.
- D. Where installed in a rack, provide a rack mount chassis with transceivers designed to mount in the chassis. The chassis shall include a 120 VAC power supply. If the quantity of rack mount transceivers required in an IDF is greater than 3, then a redundant 120 VAC power supply shall be provided. The three transceiver card cage shall be the Comnet C3 or approved equal. The

card cage designed to house more than three transceivers shall be the Comnet C2 or approved equal.

2.15 OUTDOOR CCTV CAMERA POWER SUPPLY

- A. All cameras in exterior environments connected to the system through fiber optics and installed far away from a telecommunications room shall be powered through a local outdoor CCTV camera power supply.
- B. The outdoor CCTV camera power supply shall allow for a variety of configurations for powering up to four outdoor units from a single power source and shall allow for 24 VAC output for 1-4 units. The power supply shall allow the capability to handle pan/tilt, heater, and blower operation in addition to the camera; shall allow for one fused output; and be capable of handling up to 4 A (100 VA).
- C. The outdoor power supply shall meet or exceed the following design and performance specifications:
 - 1. Input Voltage 100/120/240 VAC, 50/60 Hz
 - 2. Output Voltage 4/26/28 VAC
 - 3. Required Input Current: 1 A
 - 4. Output Fuse/Circuit Breaker Ratings 4 A
 - 5. Input Connectors: Screw-type barrier strips
 - 6. Output Connectors: Screw-type barrier strips.
 - 7. Input Wire Size: 12-16 gauge solid wire
 - 8. Output Wire Size 16-20 gauge solid or stranded wire
 - 9. Environment: Outdoor
 - 10. Operating Temperature: -50° to 122°F (-46° to 50°C)
 - 11. Construction: Aluminum
 - 12. Finish: Gray polyester powder coat
 - 13. Cable Entry: Hole plugs for 0.75-inch (1.9 cm) conduit
 - 14. Latch: Stainless steel link-lock latch; can be secured with a padlock.
 - 15. Certifications: UL
- D. Design selection: Pelco WCS1-4 or equal.

2.16 SURGE PROTECTION

- A. All CCTV components mounted outside the building shall be provided with surge and lightning protection. Provide UL listed multi-stage protection on all low voltage and signal transmission lines. All 120 VAC surge suppression devices shall be EDCO HSP121BT-1RU or an approved equal. For low voltage connections provide FAS-1 surge suppressors manufactured by EDCO or an approved equal. .
- B. For exposed Ethernet connections with PoE, use EDCO CAT6-E PoE or approved equal.

2.17 WIRE & CABLE

- A. Cables for camera power supply shall have the following specifications:

1. Minimum cable gauge: AWG 18
 2. Number of conductors: 2, stranded conductors
 3. Conductor type: Bare copper
 4. Cable insulation: PVC
 5. Conductor insulation colors: Black and red.
 6. Voltage rating: 300V
 7. Cable shield: No cable shields
- B. HDMI or DVI cables shall be factory made and tested cables. For all DVI connections use an HDMI cable with HDMI to DVI adapters. All HDMI cables shall be capable of passing a signal at 340 MHz,
- C. All UTP Category horizontal cables and fiber optic cables for the CCTV system shall be in compliance of all requirements in specification section 271000 and shall be under the same warranty as all UTP category cables and fiber optic cables described in specification section 271000. Color jacket for wiring for the CCTV system shall be green.
- D. Cable gauge: All cable gauges shall be estimated as to allow a maximum of 5% voltage drop from the source to the load. Sizes given previously are only minimum gauges accepted. The Installer shall always estimate proper values.
- E. Cable jackets: All cable jackets shall be suitable for the environment on which the cables will be installed. Use plenum rated cables when cables are installed in plenum spaces. Use riser rated cables when cables are installed through floor sleeves. Use cable jackets with water-blocking material when installed in underground conduits.
- F. Cable jackets for this project: Except when cables are run continuously in conduit all cable or patch cord cables; jackets for CCTV cables shall be plenum rated.
- G. All cables shall be RoHS compliant and free of VOC. The SSI shall provide proof of compliance for all cables during the submittal process.
- H. Acceptable manufacturers: Belden, Alpha Wire Company, General Cable and West Penn Wire.

2.18 IDENTIFICATION AND LABELING TAGS

- A. The CI shall follow labeling materials indicated in specification section 270010.

PART 3 - EXECUTION

3.1 CAMERA MOUNTING TYPES

- A. GENERAL. Cameras in the project can have different mounting types depending on how they will be installed. This is regardless if the cameras are PTZ, fixed or panoramic. The mounting type definitions are all the same regardless of the imager type. The CI shall select the correct accessories for mounting the cameras according to the types indicated in the floor plan drawings.

- B. TYPE 1: Ceiling recessed or semi-recessed application. This type of mount is for interiors, mostly in accessible ceiling spaces although it can be used in hard ceilings. Required accessories for this camera type:
 - 1. Dome backbox to protect the electronics above the ceiling, allowing for flex conduit connections and the use of secondary support string if required.
- C. TYPE 2: Surface mounted vertical mount. This type of mount is for interior or exterior applications, wall mounted. Required accessories for this camera type:
 - 1. Adapter plate (if required) to mount directly into an electrical box.
 - 2. For exterior applications, weatherproofing is required between the wall and the camera.
 - 3. For exterior applications, the lower dome shall have a hood with the ability to provide a 180 degree protection at the top of the lower dome to prevent the camera from direct sunlight and water stains.
 - 4. For installation directly in concrete walls, columns or other structures where recessing a box is not possible, a backbox is required to provide conduit knock-outs or fittings behind the camera.
- D. TYPE 3: Wall mounted. This type of mount is for interior or exterior applications, wall mounted. Required accessories for this camera type:
 - 1. Wall mount.
 - 2. Only for fixed cameras: Adapter plate (if required) to mount directly into an electrical box.
 - 3. Housing accessories required to attach the camera to the wall mount.
 - 4. When this camera type is indicated in a building corner, a corner mount adapter shall be provided as well.
- E. TYPE 4: Surface mounted horizontal mount. This type of mount is for interior or exterior applications, in hard ceiling conditions. Required accessories for this camera type:
 - 1. Adapter plate (if required) to mount directly into an electrical box.
 - 2. Rings or collars to protect the top part of the dome (if required).
 - 3. For installation directly on concrete/steel decks, a camera base with conduit knockouts or conduit fittings is required.
- F. TYPE 5: Suspended installation. This type of mount is for interior or exterior applications, suspended from ceiling or slab above. Required accessories for this camera type:
 - 1. Pole mount adapter for housing.
 - 2. Pole extension. This could be a section of steel pipe cut and threaded as required for the pole mount adapter.
 - 3. Pole base: this is the device that attaches the pole to the structure above.
 - 4. For installation directly on concrete/steel decks, a base with conduit knockouts or connections is required above the pole extension.
- G. TYPE 7: Pole mounted. This type of mount is for exterior applications on a pole. Required accessories for this camera type:
 - 1. Wall mount.
 - 2. Pole mount adapter.
 - 3. Housing accessories required to attach the camera to the wall mount.

3.2 INSTALLATION PRACTICES

- A. General: The CI shall follow all installation practices indicated in specification section 270010

3.3 WIRING METHODS

- A. All proposed wire and cable shall meet or exceed the recommendations established by the equipment manufacturers, and shall comply with all state and local codes.
- B. Visually inspect all wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps.
- C. Provide grommets and strain relief materials where necessary to avoid abrasion and excess tension on wire and cable.
- D. All penetrations through fire rated barriers shall be provided, by the CI, with appropriate fire stopping materials in accordance with NFPA requirements and local fire authority having jurisdiction.
- E. All cable runs shall be continuous from the device to the equipment. Cable splices shall not be allowed inside conduits, or cable trays.
- F. All cameras shall have a camera interface box with disconnect means to horizontal cabling for testing purposes and service. Camera interface boxes shall be located in accessible ceiling spaces as close as possible to the camera. Disconnect means shall be provided for UTP cables in the form of an 8-pin modular plug and receptacle. Disconnect means shall be provide for low voltage camera power cables in the form of insulated spade connectors (female connectors in load side, male connectors in camera side).
- G. All video cable connectors and terminations shall be 3-way crimp-on type and shall including connector cables for 24 VAC input and video/data coax output. Twist on style connectors will not be acceptable for any terminations on this project.
- H. Cables of similar signal level shall be bundled together and kept physically separate from power cords, plug strips or other circuits with different potential. Exposed wire bundles or individual cables shall be neatly secured with self-clinching nylon "TY Raps" (Thomas & Betts or equal). Lacing of cables shall not be permitted.
- I. All cables run part of the CCTV system in areas where ceiling is not accessible or in building exterior shall be in conduit at all times
- J. All termination of UTP Category type multi pair cables shall be done in Insulation Displacement Connectors (IDC), modular plugs or connectors. The use of wire nuts or manually twisting cables and protecting them with electrical tape are not acceptable means of termination.
- K. Components of the distribution system shall be installed in a neat, workmanlike manner consistent with all best practices.
- L. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the building.

3.4 IDENTIFICATION AND TAGGING

- A. All cables, wires, wiring forms, terminal blocks, and terminals shall be clearly identified by pre-printed labels or tags. The permanent markings shall clearly indicate the function, source, and destination of all cabling, wire, and terminals. All cables shall be labeled at both ends of the cable with the same and unique identifier label.
- B. Cable and equipment identifiers shall follow a standard labeling system like TIA/EIA-606. The identification system chosen by the CI shall be submitted for approval to the A&E.
- C. All camera power supplies, patch panels shall include a work sheet attached to the interior of the equipment cabinet in plastic envelopes. This work sheet shall include the location, type of device and part number of all devices connected to the boards inside those equipments. All names used to identify devices in these worksheets shall match all names and identifiers used in the software or the user interface of the system. A second copy of this worksheet shall be delivered to as part of the as-built information.

3.5 CCTV SYSTEM PROGRAMMING

- A. The CI shall program the CCTV system and the integration to the Security System as indicated in specification section 281000.
- B. IP Video Management System (IPVMS) programming: The CI is responsible for all programming and installation labor associated with the IPVMS and the CCTV workstations, as well as all components to make the system operational. The CI shall program the IPVMS system as to create the minimum amount of traffic in the network, and still comply with all resolutions and frame rates as indicated in this specification.
- C. IP video frame rate setting: The CI shall program all settings for the IPVMS following these criteria:
 - 1. The system shall be programmed for 2 different modes of operation: high activity mode and low activity mode. The CI Installer shall work with the owner to establish in a regular week for each area of the building what hours in each day are considered high activity and what hours of each day are considered low activity.
 - 2. All cameras in low traffic interior non-public hallways or rooms shall be recorded normally at 2fps @ highest resolution during high activity mode. During high activity mode frame rate shall be increased to 15 fps upon motion detection or alarm from access control system in the field of view for at least 5 minutes after motion ceased or alarm cleared. During low activity mode these cameras shall be recorded at 1 fps @ 4CIF. Upon motion detection in the field of view of those cameras, the frame rate shall be increased to 15 fps @ highest resolution for at least 5 minutes after motion ceased.
 - 3. All cameras in public areas inside the building shall be recorded at least at 15 fps @ highest resolution during high activity mode. During low activity mode cameras in these areas shall be recorded at 4 fps @ 4CIF. Upon motion detection in the field of view of those cameras, the frame rate shall be increased to 15 fps @ highest resolution for at least 5 minutes after the motion ceased.
 - 4. All site and exterior cameras shall be recorded at 15 fps @ highest resolution at all times.

3.6 ADDITIONAL INSTALLER RESPONSIBILITIES

- A. Upon project commencement, the CI shall provide qualified technical personnel on-site. Personnel shall be present on each consecutive working day until the system is fully functional and ready to begin the testing phase of this project.
- B. During the installation process the CI shall maintain an up-to-date set of as-built shop drawings, which shall always be available for review by the client and/or consulting engineers. This set of documents should be clearly annotated with as-built data as the work is performed. These documents will be reviewed as part of the approval process when evaluating payment request applications. At a minimum, the drawings should contain the following information:
 - 1. Quantity and location of all equipment installed.
 - 2. Cable and wire runs along with the designations tags assigned to each.
 - 3. Wiring diagrams that indicate terminal strip layout, identification, and terminations.
- C. The CI Project Manager shall maintain continuous coordination with the consulting engineers. The engineers shall be kept informed of the progress and all conflicts that arise during the course of this project. Prior to the start of construction the CI shall submit a complete plan and schedule for proposed operations. This schedule should include information relevant to number of employees assigned to the project, work hours, etc.

3.7 REQUEST OF IP ADDRESSES

- A. The CI shall comply with all requirements indicated in specification section 270010 for requesting IP address for the security system.

3.8 SYSTEM WARRANTY AND SERVICE

- A. General: The CI shall follow all warranty and service requirements indicated in specification section 270010.

3.9 ENGINEER'S FINAL ACCEPTANCE TEST

- A. General: The SSI shall follow all test requirements indicated in specification section 270010.
- B. Additional requirements for the system acceptance test:
 - 1. The day of the final acceptance test the CI shall have at least two (2) 2-way radios to communicate between the testing groups. Cell phones are not acceptable for communication since it takes too long to establish communication, and will delay the test substantially. Radios shall be fully charged, and spare batteries shall be available for 8 hours of use.
 - 2. The final acceptance test will be done with two groups of people. Each group will have at least one member of each stakeholder of the project (A&E, Owner, SSI, General Installer/ Construction Manager). One group will be station in the monitoring room the other group will be going to all locations in the project where security equipment is installed.
 - 3. During the final acceptance test every single camera will be tested in the system. When possible, CCTV equipment will be tested for operation during main power failure. All features requested in this specification will be tested

- C. Testing of all structured cabling system part of the Video Surveillance system shall be done in accordance of specification section 271000

3.10 SPARE PARTS

- A. As part of this project the SSI shall provide the following spare parts:
 - 1. One (1) camera of each type in the project. Electronics only, no enclosures
 - 2. One (1) rack mounted power supply
 - 3. One (1) outdoor power supply.
 - 4. One (1) monitor of each type in the project.
 - 5. One (1) additional surge suppression of each type used in the project.
- B. A list of delivered spare parts shall be included with the close out information. This list shall indicate all components delivered and shall be signed received by the Owner. The name of person receiving the equipment shall be clearly written in the list and the date it was received.

3.11 TRAINING AND INSTRUCTION

- A. General: The CI shall follow all training requirements indicated in specification section 270010.
- B. The CI shall provide two (2) levels of training for this project as explained in this section.
- C. OPERATOR/ADMINISTRATION TRAINING.
 - 1. Operator/Administration training shall be provided for security and IT personnel interacting with the CCTV system in all security monitoring rooms. The purpose of this training is to explain clearly how the complete system operates and what the different status indicators mean.
 - 2. This training shall cover at least the following topics:
 - a. Operation of the CCTV system software (all aspects).
 - b. Operation of all devices inside the security monitoring room.
 - c. Alarm response and alarm reset in the security monitoring room
 - d. Data backup/restore and achieving.
 - e. File import/export.
 - f. Creating reports and print outs.
 - g. Basic system troubleshooting.
 - h. Creating users and password reset.
 - 3. This training shall be provided by personnel working directly for the CI or a direct employee of the manufacturer of the system.
 - 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 24 hours, broken down into day sessions no longer than 6 hours each.
 - 5. Each session could have up to 20 trainees.
 - 6. The approved O&M manuals shall be available at the time of the training.
- D. MAINTENANCE TRAINING.
 - 1. Maintenance training shall be provided for maintenance and IT personnel. The purpose of this training is to explain how to troubleshoot and replace all field devices and hardware.
 - 2. This training shall cover at least the following topics:
 - a. Trouble shooting and replacement of all field devices.
 - b. Installation of all cameras and their settings (jumpers, dip switches, etc).

- c. Wire labeling system.
 - d. Software system installation and recover from system crashes.
 - e. Detail explanation on all physical keys used in CCTV devices.
 - f. Routine preventive maintenance procedures recommended by equipment manufacturers for all components of the system.
 - g. Detail explanation of source code programming for all devices that have software code specifically compiled for this project (i.e. the control system for the video wall).
3. This training shall be provided by personnel working directly for the CI or a direct employee of the manufacturer of the system.
 4. One session of this type of training shall be provided and video-taped. This session shall last no less than 18 hours, broken down into day sessions no longer than 6 hours each.
 5. Each session could have up to 5 trainees.
 6. The approved O&M manuals shall be available at the time of the training.

3.12 AS-BUILT DOCUMENTS AND CLOSE OUT INFORMATION

- A. General: The CI shall follow all as built and close out information requirements indicated in specification section 270010
- B. Additional requirements for as-built documentation shall include:
 1. Approved as-built drawings shall be a complete set of floor plans drawings, riser diagrams, and wiring details indicating the layout and interconnection of the system. All cable routings and elevation of each outlet, tie, and riser cable terminations shall be required.
 2. The content of the as-built information shall be no less than the content provided during the shop drawings, and shall be modified as per changes done during construction.
- C. Close out information shall also include:
 1. Two (2) digital backups of all configuration files and databases part of the CCTV system not earlier than the day after the final acceptance test is approved. These backups shall include a list of all the file names used and a complete description of the system that each file name belong to. The media for these backups shall be a compatible media that can be read by the computer system running the specific software program.
 2. Testing reports for structured cabling system used for the CCTV system.

END OF SECTION 282000



PROJECT MANUAL

TEMPLE UNIVERSITY HEALTH SYSTEM

ICU RENOVATION

3401 N BROAD STREET
PHILADELPHIA, PA 19140

ISSUED FOR BID

JUNE 25, 2025
Stantec Project 177902965

STANTEC ARCHITECTURE AND ENGINEERING LLC

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SECTION 024100

DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.

1.02 RELATED REQUIREMENTS

- A. Section 017419 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

- A. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
 - 1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades.
 - 2. Summary of safety procedures.
 - 3. Demolition firm qualifications.
- B. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.05 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 DEMOLITION

- A. Remove other items indicated, for salvage, relocation, and recycling.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.

3. Provide, erect, and maintain temporary barriers and security devices.
 4. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 5. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
 6. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
 7. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Protect existing structures and other elements to remain in place and not removed.
1. Provide bracing and shoring.
 2. Prevent movement or settlement of adjacent structures.
 3. Stop work immediately if adjacent structures appear to be in danger.
- D. Hazardous Materials:
1. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury.

3.03 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Existing construction and utilities indicated on drawings are based on casual field observation and existing record documents only.
1. Verify construction and utility arrangements are as indicated.
 2. Report discrepancies to Architect before disturbing existing installation.
 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Separate areas in which demolition is being conducted from areas that remain occupied.
1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 015000 in locations indicated on drawings.
- C. Maintain weatherproof exterior building enclosure, except for interruptions required for replacement or modifications; prevent water and humidity damage.
- D. Remove existing work as indicated and required to accomplish new work.
1. Remove items indicated on drawings.
- E. Services including, but not limited to, HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications: Remove existing systems and equipment as indicated.
1. Maintain existing active systems to remain in operation, and maintain access to equipment and operational components.
 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 3. See Section 011000 - Summary for limitations on outages and required notifications.
 4. Verify that abandoned services serve only abandoned facilities before removal.

5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings. Remove back to source of supply where possible, otherwise cap stub and tag with identification.
- F. Protect existing work to remain.
 1. Prevent movement of structure. Provide shoring and bracing as required.
 2. Perform cutting to accomplish removal work neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
 4. Patch to match new work.

3.04 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Owner requires that this project generate the least amount of trash and waste possible.
- C. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.
- D. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
- E. Leave site in clean condition, ready for subsequent work.
- F. Clean up spillage and wind-blown debris from public and private lands.
- G. Owner requires that this project generate the least amount of trash and waste possible. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.
- H. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
 1. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
 2. Submit Report on a form acceptable to Owner.
 3. Landfill Disposal: Include the following information:
 - a. Identification of material.
 - b. Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
 - c. State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
 - d. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
- I. Recycled and Salvaged Materials: Include the following information for each:
 1. Identification of material, including those retrieved by installer for use on other projects.
 2. Amount, in tons or cubic yards, date removed from the project site, and receiving party.
 3. Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
 4. Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
 5. Certification by receiving party that materials will not be disposed of in landfills or by incineration.
- J. Material Reused on Project: Include the following information for each:

1. Identification of material and how it was used in the project.
 2. Amount, in tons or cubic yards.
 3. Include weight tickets as evidence of quantity.
- K. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

SECTION 054000
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Formed steel stud exterior wall framing.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Wall sheathing.
- B. Section 092116 - Gypsum Board Assemblies: Cold-formed steel nonstructural framing.

1.03 DEFINITIONS

- A. General: See AISI S240 for definitions of terms used in this section.
- B. Connection: A combination of structural elements and joints used to transmit forces between two or more members.
- C. Connector: A device used to transmit forces between cold-formed steel structural members or between a cold-formed steel structural member and another structural element.

1.04 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members.
- B. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data.
- C. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing.
- D. {RSTEMP#311}ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures;Most Recent Edition Cited by Referring Code or Reference Standard.
- E. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- F. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- G. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
- H. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- I. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification.
- J. ICC (IBC) - International Building Code.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with work of other sections that is to be installed in or adjacent to metal framing systems, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on cold-formed steel structural members; include material descriptions and base steel thickness.
- C. Product Data: Provide manufacturer's data on factory-made connectors and mechanical fasteners, showing compliance with requirements.
- D. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
 - 1. Indicate stud layout.
 - 2. Describe method for securing studs to tracks and for bolted framing connections.
- E. Design Data:
 - 1. Shop drawings signed and sealed by a professional structural engineer.
 - 2. Design calculations sufficient to demonstrate compliance with design criteria; signed and sealed by a professional structural engineer.
 - 3. Details and calculations for factory-made connectors, signed and sealed by a professional structural engineer.
- F. Evaluation Service Reports: Provide reports indicating compliance with specified requirements for cold-formed steel structural members.
- G. Inspection Reports: Provide material verification Inspection Reports in accordance with requirements of AISI S240.
- H. Inspection Reports: Provide Inspection Reports for welding, mechanical fastening, and cold-formed steel light-frame construction in accordance with requirements of AISI S240.
- I. Manufacturer's Installation Instructions: Provide installation instructions for connectors and mechanical fasteners.
- J. Manufacturer's Installation Instructions: For lateral-force resisting systems, indicate welding procedure specifications and mechanical fastener installation procedures.
- K. Installation Drawings: Indicate dimensioned locations of cold-formed steel structural framing.
 - 1. Include materials, corrosion protection, base steel thickness, and dimensions.
- L. Designer's Qualification Statement.
- M. Manufacturer's Qualification statement.
- N. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before the start of scheduled welding work.

1.07 QUALITY ASSURANCE

- A. See Section 014000 - Quality Requirements for additional requirements.

- B. Designer Qualifications: Design framing system under direct supervision of a professional structural engineer experienced in designing this work and licensed in the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with requirements for Contractor's design-related professional design services indicated in Section 014000 - Quality Requirements.
- B. Design Requirements: Design cold-formed framing systems, components and connectors to withstand specified design loads in compliance with ICC (IBC), {rs\#1}, AISI S100, and AISI S240.
- C. Design Criteria: In accordance with applicable codes.
 - 1. Live load deflection meeting the following, unless otherwise indicated:
 - a. Exterior Walls: Maximum horizontal deflection under wind load of 1/180 of span.
 - b. Design nonaxial loadbearing framing to accommodate not less than 1/2 in vertical deflection.
 - 2. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
 - 3. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
- D. Fabrication:
 - 1. Shop-fabricate cold-formed framing systems and connectors to the greatest extent possible.
 - 2. Deliver to project site in largest practical sections.

2.02 MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
 - 1. Structural Grade: As required to meet design criteria.
 - 2. Corrosion Protection Coating Designation: CP 60 in accordance with AISI S240.

2.03 STRUCTURAL FRAMING COMPONENTS

- A. Wall Studs and Track Sections: AISI S240; c-shaped studs and u-shaped track sections in stud-matching nominal width and compatible height.
 - 1. Thickness and Depth: Depth as indicated on the drawings; thickness and structural grade as required to meet design criteria.

- B. Headers: AISI S240; manufactured, engineered one-member or two-member assemblies, with wide flanges, designed to replace conventional box or nested header framing at openings.
 - 1. Thickness and Depth: Depth as indicated on drawings; thickness and structural grade as required to meet specified design criteria.
 - 2. Jamb Mounting Clips: Manufacturer's standard.

2.04 LATERAL FORCE-RESISTING SYSTEMS

- A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
 - 1. Structural Grade: As required to meet design criteria.
 - 2. Corrosion Protection Coating Designation: CP 60 in accordance with AISI S240.
- B. Curtain Wall Studs and Girts:
 - 1. Thickness and Depth: Depth as indicated on the drawings; thickness and structural grade as required to meet design criteria.

2.05 CONNECTIONS

- A. Performance Requirements: Provide connections in compliance with requirements of AISI S240.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S240.
 - 1. Structural Grade: As required to meet design criteria.
 - 2. Corrosion Protection Coating Designation: CP 60 in accordance with AISI S240.
- C. Structural Performance: Maintain load and movement capacity required by applicable building code and specified design criteria.
- D. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, shouldered screws or screws and anti-friction or stepped bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.
 - 1. Where continuous studs bypass elevated floor slab, connect stud to slab in manner allowing vertical and horizontal movement of slab without affecting studs; allow for minimum movement of 1/2 inch.
 - 2. Where top of stud wall terminates below structural floor or roof, connect studs to structure in manner allowing vertical and horizontal movement of slab without affecting studs; allow for minimum movement of 1/2 inch.
 - 3. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 10 feet.

2.06 MISCELLANEOUS CONNECTIONS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot-dip galvanized per ASTM A153/A153M.
- B. Anchorage Devices: Powder actuated.
- C. Welding: Comply with AWS D1.1/D1.1M.

2.07 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
- B. Galvanizing Repair: Touch up bare steel with zinc-rich paint in compliance with ASTM A780/A780M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify field measurements and adjust installation as required.

3.02 PREPARATION

3.03 INSTALLATION - GENERAL

- A. Install structural members and connections in compliance with ASTM C1007.

3.04 INSTALLATION OF STUDS

- A. Install wall studs plumb and level.
- B. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
- C. Install load-bearing studs full length in one piece. Splicing of studs is not permitted.
- D. Install load-bearing studs; brace, and reinforce to develop full strength and achieve design requirements.
- E. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- F. Install intermediate studs above and below openings to align with wall stud spacing.
- G. Provide deflection allowance in stud track, directly below horizontal building framing at non-loadbearing framing.
- H. Attach cross studs to studs for attachment of fixtures anchored to walls.
- I. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- J. Touch-up field welds and damaged corrosion-protected surfaces zinc-rich paint in compliance with ASTM A780/A780M.

3.05 INSTALLATION OF WALL SHEATHING

- A. Install wall sheathing with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using self-tapping screws.

3.06 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Provide material verification inspections in accordance with requirements of AISI S240.
- C. Provide inspections for welding, mechanical fastening, and cold-formed steel light-frame construction in accordance with requirements of AISI S240.

3.07 TOLERANCES

- A. Studs - Vertical Alignment (Plumbness): $1/960$ of span or $1/8$ inch in 10 ft, in accordance with ASTM C1007.
- B. Studs - Maximum Variation from True Position: $1/8$ inch in accordance with ASTM C1007.
- C. Stud Spacing: $1/8$ inch from the designated spacing, provided that the cumulative error does not exceed the requirements of the finishing materials in accordance with ASTM C1007.

SECTION 055100

METAL STAIRS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stairs with grating treads.
- B. Structural steel stair framing and supports.
- C. Handrails and guards.

1.02 RELATED REQUIREMENTS

- A. Section 099000 - Painting and Coating: Paint finish.

1.03 REFERENCE STANDARDS

- A. AISC 201 - AISC Certification Program for Structural Steel Fabricators, Standard for Steel Building Structures.
- B. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
- C. {RSTEMP#451}ASTM A36/A36M - Standard Specification for Carbon Structural Steel{CH#29506}.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- G. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- H. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- I. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification.
- J. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- K. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172.
- L. NAAMM AMP 510 - Metal Stairs Manual.
- M. NAAMM MBG 531 - Metal Bar Grating Manual.
- N. NAAMM MBG 532 - Heavy Duty Metal Bar Grating Manual.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
- C. Design Data: As required by authorities having jurisdiction.
- D. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- E. Designer's Qualification Statement.
- F. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is certified under AISC 201.
- G. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.05 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.
- B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and dated no more than 12 months before start of scheduled welding work.
- C. Fabricator Qualifications:

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 - 1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
 - 2. Structural Design: Provide complete stair and railing assemblies that comply with the applicable local code.
 - 3. Dimensions: As indicated on drawings.
 - 4. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 - 5. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 - 6. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
 - 1. Service: Exposed joints tight with face surfaces aligned; underside of stair not covered by soffit is not considered exposed to view.
 - a. Welded Joints: Welded on back side wherever possible.
 - b. Welds Exposed to View: Ground smooth; not required to be flush.

- c. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts or screw threads.
 - d. Metal Surfaces to be Painted: Sanded smooth, suitable for satin or matte finish.
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH GRATING TREADS

- A. Jointing and Finish Quality Level: Service, as defined above.
- B. Risers: Open.
- C. Treads: Steel bar grating.
 - 1. Grating Type: Welded.
 - 2. Bearing Bar Depth: 3/4 inch, minimum, as required by delegated design.
 - 3. Top Surface: Standard.
 - 4. Nosing: Checkered plate.
 - 5. Nosing Width: 1-1/4 inch, minimum.
 - 6. Anchorage to Stringers: End plates welded to grating, bolted to stringers.
- D. Stringers: Rolled steel channels.
 - 1. Stringer Depth: As indicated on drawings.
 - 2. End Closure: Sheet steel, 14 gauge, 0.075 inch minimum; welded across ends.
- E. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.
- F. Railings: Steel picket railings.
- G. Finish: Galvanized after fabrication.

2.03 HANDRAILS AND GUARDS

- A. Handrails: Round pipe or tube rails unless otherwise indicated.
 - 1. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
- B. Guards:
 - 1. Top Rails: Round pipe or tube rails unless otherwise indicated.
 - a. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
 - 2. Infill at Picket Railings: Vertical pickets.
 - a. Horizontal Spacing: Maximum 4 inches on center.
 - b. Material: Solid steel bar.
 - c. Shape: Square.
 - d. Size: 1/2 inch square.
 - e. Top Mounting: Welded to underside of top rail.
 - f. Bottom Mounting: Welded to top surface of stringer.
 - 3. End and Intermediate Posts: Same material and size as top rails.
 - a. Horizontal Spacing: As indicated on drawings.
 - b. Mounting: Welded to top surface of stringer.

2.04 MATERIALS

- A. Steel Sections: {\rs\#1}.
- B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.
- C. Steel Plates: ASTM A6/A6M or ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M Grade B Schedule 40, black finish.
- E. Gratings: Bar gratings that comply with NAAMM MBG 531 or NAAMM MBG 532, whichever applies based on bar sizes.

2.05 SHOP FINISHING

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Galvanizing: Hot-dip galvanize to minimum requirements of ASTM A123/A123M.
 - 1. Touch up abraded areas after fabrication using specified touch-up primer for galvanized surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. When field welding is required, clean and strip primed steel items to bare metal.

3.03 INSTALLATION

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.
- F. Obtain approval prior to site cutting or creating adjustments not scheduled.
- G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

SECTION 061000
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sheathing.
- B. Preservative treated wood materials.
- C. Fire retardant treated wood materials.
- D. Communications and electrical room mounting boards.
- E. Concealed wood blocking, nailers, and supports.

1.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- B. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. AWPA U1 - Use Category System: User Specification for Treated Wood.
- E. PS 1 - Structural Plywood.
- F. PS 2 - Performance Standard for Wood Structural Panels.
- G. PS 20 - American Softwood Lumber Standard.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Sizes: Nominal sizes as indicated on drawings, S4S.
- B. Moisture Content: S-dry or MC19.
- C. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

- A. Wall Sheathing: PS 2 type.
 - 1. Bond Classification: Exterior.
 - 2. Grade: Structural I Sheathing.
 - 3. Fire Resistance: Noncombustible, fire-retardant treated.
 - 4. Span Rating: 24.
 - 5. Performance Category: 5/8 PERF CAT.
 - 6. Edge Profile: Square edge.
- B. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- C. Other Applications:
 - 1. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
 - 2. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
 - 3. Other Locations: PS 1, C-D Plugged or better.

2.04 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWP A U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWP A standards.
- B. Fire Retardant Treatment:
 - 1. Exterior Type: AWP A U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat exterior rough carpentry items.
 - c. Do not use treated wood in direct contact with the ground.
 - 2. Interior Type A: AWP A U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated .
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
 - 1. Preservative Pressure Treatment of Lumber Above Grade: AWP A U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber exposed to weather.
 - c. Treat lumber in contact with roofing, flashing, or waterproofing.
 - d. Treat lumber in contact with masonry or concrete.
 - e. Treat lumber in other locations as indicated.
 - 2. Preservative Pressure Treatment of Plywood Above Grade: AWP A U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - b. Treat plywood in contact with roofing, flashing, or waterproofing.
 - c. Treat plywood in contact with masonry or concrete.
 - d. Treat plywood less than 18 inches above grade.
 - e. Treat plywood in other locations as indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

3.04 ROOF-RELATED CARPENTRY

- A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.

3.05 INSTALLATION OF CONSTRUCTION PANELS

- A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.
 - 1. Install plywood wall sheathing in accordance with manufacturer's current ICC-ES evaluation report for specified sheathing product.
- B. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.
 - 4. Size and Location: As indicated on drawings.

3.06 CLEANING

- A. Waste Disposal: See Section 017419 - Construction Waste Management and Disposal.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.

- C. Prevent sawdust and wood shavings from entering the storm drainage system.

SECTION 064100
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Hardware.
- C. Factory finishing.
- D. Preparation for installing utilities.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- B. Section 123600 - Countertops.

1.03 REFERENCE STANDARDS

- A. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications.
- B. AWI (QCP) - Quality Certification Program.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.
- E. BHMA A156.9 - Cabinet Hardware.
- F. NEMA LD 3 - High-Pressure Decorative Laminates.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 013300 - Submittal Procedures for submittal procedures.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
 - 2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
 - 3. Include certification program label.
- C. Product Data: Provide data for hardware accessories.

- D. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.
- E. Samples: Submit actual sample items of proposed pulls and locksets, demonstrating hardware design, quality, and finish.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
 - 2. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
 - 3. Single Source Responsibility: Provide and install this work from single fabricator.
- B. Quality Certification:
 - 1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
 - 2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 3. Provide designated labels on shop drawings as required by certification program.
 - 4. Provide designated labels on installed products as required by certification program.
 - 5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
 - 6. Replace, repair, or rework all work for which certification is refused.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

1.08 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise to be Premium.
- B. Plastic Laminate Faced Cabinets: Custom grade, unless otherwise indicated on the Drawings to be Premium.
- C. Cabinets:
 - 1. Finish - Exposed Exterior Surfaces: Decorative laminate.
 - 2. Finish - Exposed Interior Surfaces: Decorative laminate.
 - 3. Finish - Semi-Exposed Surfaces: Decorative laminate
 - 4. Finish - Concealed Surfaces: Manufacturer's option.

5. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
6. Casework Construction Type: Type A - Frameless.
7. Interface Style for Cabinet and Door: Style 1 - Overlay; flush overlay.
8. Cabinet Design Series: As indicated on drawings.
9. Adjustable Shelf Loading: 50 psf.
 - a. Deflection: L/144.
10. Cabinet Style: Flush overlay.
11. Cabinet Doors and Drawer Fronts: Flush style.
12. Drawer Side Construction: Multiple-dovetailed.
13. Drawer Construction Technique: Dovetail joints.

2.02 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

2.03 PANEL CORE MATERIALS

- A. Particleboard: Composite panel composed of cellulosic particles, additives, and bonding system; comply with ANSI A208.1.
 1. Grade: M-2; moisture resistance: MR30.
 2. Panel Thickness: As indicated on drawings.

2.04 THERMALLY FUSED LAMINATE PANELS

- A. Thermally Fused Laminate (TFL): Melamine- or polyester-resin-saturated decorative papers; for fusion to composite wood substrates under heat and pressure.
 1. Test in accordance with NEMA LD 3 Section 3.
 2. Panel Core Substrate: Medium Density Fiberboard (MDF).
 3. Color: As selected from manufacturer's standard range of colors.

2.05 LAMINATE MATERIALS

- A. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- B. Provide specific types as indicated.
 1. Horizontal Surfaces: HGL, 0.039 inch nominal thickness, colors as indicated, finish as selected.
 2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, colors as indicated, finish as selected.
 3. Cabinet Liner: CLS, 0.020 inch nominal thickness, colors as indicated, finish as selected.

2.06 COUNTERTOPS

- A. Countertops: See Section 123600.

2.07 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.

1. Color: As selected by Architect from manufacturer's standard range.
 2. Use at all exposed panel and shelf edges.
- C. Fasteners: Size and type to suit application.
- D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- E. Concealed Joint Fasteners: Threaded steel.
- F. Grommets: Standard plastic grommets for cut-outs, in color to match adjacent surface.

2.08 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.
- C. Workstation Brackets: Fixed, L-shaped, corner reinforced, face-of-wall mounting.
1. Materials: Formed steel shapes.
 - a. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 - b. Color: As selected by Architect..
 2. Height: 18 inches.
 3. Support Length: 21 inches.
 4. Products:
 - a. A&M Hardware, Inc; Standard Brackets: www.aandmhardware.com/#sle.
- D. Countertop Support Brackets: Fixed, L-shaped, face-of-wall mounting.
1. Materials: Steel; Flat cross-section.
 - a. Finish: Manufacturer's standard, factory-applied, powder coat.
 - b. Height: 12 inches - see drawings.
 - c. Height: 18 inches - see drawings.
 - d. Support Length: 12 inches - see drawings.
 - e. Support Length: 18 inches - see drawings.
 - f. Width: 1-1/2 inches.
 2. Products:
 - a. A&M Hardware, Inc; Hybrid Brackets: www.aandmhardware.com/#sle.
- E. Countertop Brackets: Fixed, concealed vertical leg, side-of-stud mounting.
1. Materials: Steel T-shapes.
 - a. Finish: Manufacturer's standard, factory-applied, powder coat.
 - b. Color: Field paint to match wall color..
 - c. Vertical Leg: 26 inches.
 - d. Support Member Depth: 2 inches.
 - e. Support Member Width: 2 inches
 - f. Support Member Length: 18 inches.
 2. Products:
 - a. A&M Hardware, Inc; Concealed Brackets: www.aandmhardware.com/#sle.
- F. Drawer and Door Pulls: "U" shaped wire pull, steel with satin finish, 4 inch centers.

- G. Built-In Combination Cabinet Locks:
 - 1. Digital combination locks.
- H. Cabinet Catches and Latches:
 - 1. Type: Magnetic catch.
- I. Drawer Slides:
 - 1. Type: Extension types as indicated.
 - 2. Type: Two-way travel type.
 - 3. Disconnects: Provide drawer slides with disconnects as scheduled.
 - 4. Static Load Capacity: Extra Heavy Duty grade where scheduled.
 - 5. Static Load Capacity: Heavy Duty grade where scheduled.
 - 6. Mounting: Side mounted.
 - 7. Stops: Integral type.
 - 8. Features: Provide self closing/stay closed type.
- J. Soft-Close, Door and Drawer Adjustable Dampers:
- K. Hinges: European style concealed self-closing type, steel with nickel-plated finish.
- L. Keyboard Tray: Integral ball-bearing slides; adjustable tilt, gel palm rest, storage compartments, cable management, and mouse pad.

2.09 FABRICATION

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- C. Use fixture attachments in concealed locations for wall mounted components.

- D. Use concealed joint fasteners to align and secure adjoining cabinet units.
- E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- F. Secure cabinets to floor using appropriate angles and anchorages.
- G. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 ADJUSTING

- A. Adjust installed work.
- B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

SECTION 064200
WOOD PANELING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Custom wood fiber paneling.

1.02 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Field finishing.

1.03 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on fire-retardant treatment materials and application instructions.
- C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
 - 2. Provide plan of panel number sequencing.
- D. Samples: Submit two samples of finished panels, 12 x 12 inch in size, illustrating wood texture and specified finish.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect work from moisture damage.
- B. Do not deliver wood materials to project site until building is fully enclosed and interior temperature and humidity are in accordance with recommendations of AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for fire-retardant requirements.

2.02 PANELING

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.
- B. Manufacturer: Interlam Corp.
 - 1. Product: Interlam Art Diffusion Wall Pane
- C. Flakeboard FR 1 ½" thick 48" x 96" fibre core panel.
- D. Finish: Factory primed and sanded for field finishing.
- E. Pattern to be carved in vertical orientation and installed in horizontal orientation.

2.03 WOOD-BASED MATERIALS - GENERAL

- A. Particleboard: Composed of wood chips, medium density, with waterproof resin binders; of grade to suit application; sanded faces; complying with ANSI A208.1.

2.04 ADHESIVES AND FASTENERS

- A. Adhesives: Type suitable for intended purpose, complying with applicable air quality regulations.

2.05 WOOD-TREATMENT PROCESSES

- A. Fire-Retardant Treatment (FR-S Type) for Lumber: Chemically treated and pressure impregnated; capable of providing flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.

2.06 FABRICATION

- A. Shop prepare and identify panels for grain matching during site erection.
- B. Prepare panels for delivery to site, permitting passage through building openings.
- C. Finish exposed edges of panels as specified by grade requirements.
- D. When necessary to cut and fit on site, provide materials with ample allowance for cutting and scribing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated on shop drawings.
- B. Verify adequacy of backing and support framing.
- C. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.

- B. Do not begin installation until wood materials have been fully acclimated to interior conditions.
- C. Set and secure materials and components in place, plumb and level, using concealed fasteners wherever possible.
- D. Panel to be mounted directly to drywall using PL Premium Polyurethane adhesive (www.stickwithpl.com) and face screwed into studs or blocking.

3.03 PREPARATION FOR FIELD FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
- B. Screw holes should be filled with an automotive body filler such as bondo and the seams should be filled with a flexible seam filler that is compatible with the topcoat. The seams should be allowed to dry and flush sanded prior to field applied top coat.
- C. Field Finishing: See Section 099000.

3.04 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch.
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

SECTION 070150.19

PREPARATION FOR RE-ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal of limited portions of existing roofing system in preparation for incorporating new construction and flashing of same with existing roof system.
- B. Removal of existing flashing and counterflashings to incorporate new construction.
- C. Temporary roofing protection.

1.02 RELATED REQUIREMENTS

- A. Section 076200 - Sheet Metal Flashing and Trim: Replacement of flashing and counterflashings.
- B. Section 077100 - Roof Specialties : Pre-manufactured roof accessories included copings and gravel stops.

1.03 REFERENCE STANDARDS

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with affected mechanical and electrical work associated with roof penetrations.
- B. Preinstallation Meeting: Convene one week before starting work of this section.
 - 1. Attendees:
 - a. Architect.
 - b. Contractor.
 - c. Owner.
 - d. Installer.
 - e. Roofing system manufacturer's field representative.
 - 2. Meeting Agenda: Provide agenda to participants prior to meeting in preparation for discussions on the following:
 - a. Removal and installation schedule.
 - b. Necessary preparatory work.
 - c. Protection before, during, and after roofing system installation.
 - d. Removal of existing roofing system components necessary to perform the work.
 - e. Installation of new roofing flashing and related work.
 - f. Temporary roofing and daily terminations.
 - g. Transitions and connection to and with other work.
 - h. Inspections and testing of installed systems.
- C. Schedule work to coincide with commencement of installation of new roofing system.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit for each type of material.
- C. Shop Drawings: Indicate size, configuration, and installation details.
- D. Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
 - 1. Approved by existing roofing system warrantor to work on existing warranted roof system.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.

1.08 FIELD CONDITIONS

- A. Existing Roofing System: Modified bituminous roofing. An Owner's copy of the existing roof system information is available for review and coordination.
- B. Do not remove existing roofing membrane and components when weather conditions threaten the integrity of building contents or intended continued occupancy.
- C. Maintain continuous temporary protection prior to and during installation of new roofing components.
- D. Provide notice at least three days before starting activities that will affect normal building operations.
- E. Owner will occupy building areas directly below re-roofing area.
 - 1. Provide Owner with at least 48 hours written notice of roofing activities that may affect their operations and to allow them to prepare for upcoming activities as necessary.
 - 2. Do not disrupt Owner's operations or activities.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Existing Warranties: Perform this work using methods and materials that will maintain existing roof system warranties.
 - 1. Notify existing roof system warrantor prior to starting this work and obtain written instructions for procedures necessary to maintain this existing warranty.
 - 2. Upon completion of this work, notify warrantor of reroofing completion and obtain documentation to verify that existing roofing system has been inspected and warranty is still in effect.
 - a. Submit documentation upon project closeout.

PART 2 PRODUCTS

2.01 COMPONENTS

- A. See the following sections for additional information on components relating to this work:
 - 1. New roofing system components to tie into existing roofing in designated areas as indicated on drawings.

2.02 MATERIALS

- A. Temporary Roofing Protection Materials:
 - 1. Contractor's responsibility to select appropriate materials for temporary protection of roofing areas as determined necessary for this work.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that areas of roof surface where tie-in is to occur has been cleared of materials being removed from existing roofing system.

3.02 PREPARATION

- A. Sweep roof surface clean of loose matter.
- B. Remove loose refuse and dispose of properly off-site.

3.03 MATERIAL REMOVAL

- A. Remove only existing roofing materials that can be replaced with new materials as the weather will permit.
- B. Remove metal counter flashings.
- C. Remove damaged insulation and fasteners, cant strips, and blocking in areas impacted by new construction and new flashing.

3.04 INSTALLATION

- A. Coordinate scope of this work with requirements for installation of new roofing system, see Section 075300 for additional requirements.

3.05 FIELD QUALITY CONTROL

- A. The drawings identify the approximate limits to material removal.

3.06 PROTECTION

- A. Provide protection of existing roofing system that is not having work performed on it.
- B. Turn sheeting up and over parapets and curbing. Retain sheeting in position with temporary fasteners.
- C. Provide for surface drainage from sheeting to existing drainage facilities.

- D. Do not permit traffic over unprotected or repaired deck surface.

3.07 SCHEDULES

- A. Existing Roofing Areas as Indicated: Remove existing perimeter flashings, base flashings, counter flashings, and roofing membrane as necessary to perform tie-in of new construction to existing roof membrane system.
- B. Remove roof mounted mechanical equipment, electrical equipment, and other construction as indicated on the drawings and as necessary to perform the new work.

SECTION 072100
THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Board insulation at exterior wall construction.
- B. Batt insulation in exterior wall construction.
- C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 DEFINITIONS

- A. Mineral Fiber Material Composition: Insulation referred to as mineral fiber block, board, and blanket insulation is composed of fibers from mineral based substances such as rock, slag, or glass and processed from the molten state into fibrous form.
 - 1. Based on type of insulation substance, the material will be referred to as a mineral fiber when having a rock or slag base, and glass fiber with a glass or silica sand base, also considered a mineral.
 - 2. Insulation blankets are flexible units consisting of felted, bonded, or unbonded fibers formed into rolls or flat cut pieces referred to as batts; rolls are simply longer versions of batts.
 - 3. For additional information about mineral fiber and the various classification types, refer to the following reference standards; ASTM C553, ASTM C612, ASTM C665, and ASTM C726.

1.03 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- E. ASTM C726 - Standard Specification for Mineral Wool Roof Insulation Board.
- F. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. {RSTEMP#1159}ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials{CH#36143}.

- I. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies.
- J. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Shop Drawings: Submit drawings that indicate location of joint or termination detail conditions.

1.05 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Insulation at Curtainwalls: Mineral fiber board.
- B. Insulation Over Metal Stud Framed Walls: Polyisocyanurate board.
- C. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.

2.02 FOAM BOARD INSULATION MATERIALS

- A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, comply with ASTM C1289.
 - 1. Classifications:
 - a. Type I: Faced with aluminum foil on both major surfaces of the core foam.
 - 1) Class 1 - Non-reinforced core foam.
 - 2) Compressive Strength: 16 psi, minimum.
 - 3) Thermal Resistance, R-value: At 1-1/2 inch thick; 9.0, minimum, at 75 degrees F.
 - 2. Water Vapor Permeance: 0.05 perm, maximum, at 1 inch thickness, and when tested in accordance with {RS#1159}, desiccant method.
 - 3. Comply with fire resistance requirements indicated on drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
 - 4. Board Size: 48 inch by 96 inch.
 - 5. Board Edges: Square.

2.03 MINERAL FIBER BOARD INSULATION MATERIALS

- A. Mineral Wool Block, Board, or Blanket Thermal Insulation: Complying with ASTM C612 or ASTM C553.
 - 1. Where indicated, provide foil facing on one side; with flame spread index of 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.

3. Board Size: 48 by 48 inches.
4. Board Thickness: 3 inches.
5. Thermal Resistance: R-value of 4.2 per inch at 75 degrees F, minimum, when tested in accordance with ASTM C518.
6. Products:
 - a. Johns Manville; MinWool 40 Curtainwall: www.jm.com/#sle.
 - b. ROCKWOOL; CURTAINROCK 40: www.rockwool.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.

2.04 MINERAL FIBER BLANKET INSULATION MATERIALS

- A. Mineral Wool Blanket Thermal Insulation: Flexible or semi-rigid preformed insulation, complying with ASTM C665.
 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
 3. Thermal Resistance: R-value of that indicated on Drawings.
 4. Thickness: As indicated on Drawings.
 5. Products:
 - a. ROCKWOOL; COMFORTBATT: www.rockwool.com/#sle.

2.05 ACCESSORIES

- A. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.
 1. Application: Sealing of interior circular penetrations, such as pipes or cables.
 2. Width: As required for application.
- B. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.
 1. Products:
 - a. Rmax Inc; R-SEAL 3000: www.rmax.com/#sle.
- C. Mineral Wool Insulation Attachment:
 1. Products:
 - a. TruFast Walls, a Division of Altenloh, Brinck & Co. US, Inc; Grip-Lok MW Plate: www.trufastwalls.com/#sle.
- D. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT EXTERIOR WALLS

- A. Adhere 6 inches wide strip of polyethylene sheet over expansion joints with double beads of adhesive each side of joint.

- B. Install rigid insulation directly to steel studs or exterior grade sheathing at 16 inches on center with manufacturer recommended mechanical fasteners, and tape joints with manufacturer's minimum 4 inches wide sealant tape; comply with ASTM E2357.
- C. Install boards horizontally on walls.
- D. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION AT CAVITY WALLS

- A. Secure insulation fasteners to substrate at following frequency:
- B. Install boards to fit snugly between wall ties.
- C. Install boards horizontally on walls.
- D. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.04 BATT INSTALLATION

- A. Install insulation in accordance with manufacturer's instructions.
- B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. Retain insulation batts in place with spindle fasteners at 12 inches on center.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.

3.06 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

SECTION 072119
FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Foamed-in-place insulation.
 - 1. In exterior framed walls.
 - 2. At junctions of dissimilar wall and roof materials.
- B. Protective intumescent coating.

1.02 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- B. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. {RSTEMP#1159}ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials{CH#37196}.
- E. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials.
- F. FM 4880 - Examination Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials.
- G. NFPA 275 - Standard Method of Fire Tests for the Evaluation of Thermal Barriers.
- H. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components.
- I. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.
- J. UL 1040 - Standard for Safety Fire Test of Insulated Wall Construction.
- K. UL 1715 - Standard for Safety Fire Test of Interior Finish Material.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week prior to commencing work of this section.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product description, specifications, material safety data sheets, insulation properties, overcoat properties, and preparation and installation requirements.

- C. Shop Drawings: Show project specific locations and extent of insulation.
- D. Certificates: Certify that products of this section meet or exceed specified requirements.
- E. ABAA Field Quality Control Submittals: Submit third-party reports of testing and inspection as required by ABAA QAP.
- F. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.
- G. Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.
- H. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer certification on site during and after installation. Present on-site documentation upon request.

1.05 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by qualified testing agency.-
- B. Field quality-control reports.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than five years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified, with minimum five years of documented experience, and approved by manufacturer.

1.07 FIELD CONDITIONS

- A. Coordinate Work under this Section with adjacent trades.
- B. Do not install spray polyurethane foam during precipitation or when precipitation is imminent.
- C. Do not apply foam when temperature is outside of temperature range specified by the manufacturer for ambient air and substrate.
- D. Do not apply foam when temperature is within 5 degrees F of dew point.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Foamed-In-Place Insulation:
 - 1. BASF Corporation: www.spf.basf.com/#sle.
 - 2. Carlisle Spray Foam Insulation: www.carlislefsi.com/#sle.
 - 3. Johns Manville: www.jm.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.02 MATERIALS

- A. Foamed-In-Place Insulation: Medium-density, rigid or semi-rigid, closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.

1. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.
 - a. Fire Protection: Provide 15-minute thermal barrier of 1/2 inch gypsum board or equivalent material complying with NFPA 275 test method, or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715.
2. Thermal Resistance: R-value of 6.9, minimum, per 1 inch thickness at 75 degrees F mean temperature when tested in accordance with ASTM C518.
3. Water Vapor Permeance: Vapor retarder; 0.8 perms at 1 inch, 0.23 perms at 3 inches, maximum, when tested at intended thickness in accordance with {RS#1159}, desiccant method.
4. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
5. Air Permeance: 0.02 cfm per square foot, maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf.
6. Core density: Provide core density of 2 PCF minimum when tested in accordance with ASTM D1622.
7. Closed Cell Content: At least 90 percent.
8. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
9. Basis of Design:
 - a. Carlisle Spray Foam Insulation; SealTite PRO Closed Cell: www.carlisesfi.com/#sle.
10. Other Acceptable Products:
 - a. BASF Corporation; WALLTITE US: www.spf.basf.com/#sle.
 - b. Carlisle Spray Foam Insulation; SealTite PRO One Zero: www.carlisesfi.com/#sle.
 - c. Johns Manville; JM Corbond III Closed Cell Spray Polyurethane Foam: www.jm.com/#sle.

2.03 ACCESSORIES

- A. Primer: As required by insulation manufacturer.
- B. Protective Coating: Intumescent coating of type recommended by insulation manufacturer and as required to comply with applicable codes.
 1. Coating Type: Single component, water-based.
 2. Protected Insulation Type: Spray polyurethane foam (SPF).
 3. Application: Apply using brush, roller, or airless sprayer.
 4. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
 5. Exterior Wall System: Comply with NFPA 285.
 6. Color: White.
 7. Products:
 - a. No-Burn, Inc; Plus ThB Intumescent Coating: www.noburn.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify work within construction spaces or crevices is complete before insulation application.

- B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation adhesion.

3.02 PREPARATION

- A. Mask and protect adjacent surfaces from over spray or dusting.
- B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION

- A. Apply insulation in accordance with manufacturer's instructions.
- B. Apply insulation by spray method, to a uniform monolithic density without voids.
- C. Do not spray into rising foam.
- D. Apply to a minimum cured thickness of dimensions shown on drawings.
- E. Patch damaged areas.
- F. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.
- G. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Field inspections and tests will be performed by an independent testing agency.
- C. Inspection will include verification of insulation and protective coating thickness and density.
- D. Coordination of Tests and Inspections:
 - 1. Provide testing and inspection required by ABAA QAP.
 - 2. Notify in testing agency writing of schedule for air barrier work. Allow adequate time for testing and inspection.
 - 3. Cooperate with testing agency.
 - 4. Allow access to air barrier work areas and staging.
 - 5. Do not cover air barrier work until tested, inspected, and accepted.

3.05 PROTECTION

- A. Do not permit subsequent construction work to disturb applied insulation.
- B. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- C. Protect thermal barrier from damage.

SECTION 076200

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings, counterflashings, and exterior penetrations.
- B. Sealants for joints within sheet metal fabrications.

1.02 RELATED REQUIREMENTS

- A. Section 077200 - Roof Accessories: Manufactured roof accessories .

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- D. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free.
- E. CDA A4050 - Copper in Architecture - Handbook.
- F. SMACNA (ASMM) - Architectural Sheet Metal Manual.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

- A. Pre-Finished Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 18 gauge, 0.040 inch thick; plain finish shop pre-coated with PVDF coating.
 - 1. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; pretreated metal with two-coat system including primer and color coat with at least 70 percent PVDF coating.

2.02 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.
- F. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.
- G. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.03 ACCESSORIES

- A. Fasteners: Stainless steel, with soft neoprene washers.
- B. Primer Type: Zinc chromate.
- C. Concealed Sealants: Non-curing butyl sealant.
- D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- E. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch.

3.03 INSTALLATION

- A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- B. Apply plastic cement compound between metal flashings and felt flashings.
- C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- D. Seal metal joints watertight.

SECTION 077100
ROOF SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured roof specialties, including copings, fascias, and gravel stops.

1.02 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix).
- B. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems.
- C. NRCA (RM) - The NRCA Roofing Manual.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on shape of components, materials and finishes, anchor types and locations.
- C. Shop Drawings: Indicate configuration and dimension of components, site specific adjacent construction, required clearances and tolerances, and other affected work.
- D. Samples: Submit two appropriately sized samples of coping.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Roof Edge Flashings and Copings:
 - 1. ATAS International, Inc: www.atas.com/#sle.
 - 2. Hickman Edge Systems: www.hickmanedgesystems.com/#sle.
 - 3. Metal-Era Inc: www.metalera.com/#sle.
 - 4. Metal Roofing Systems, Inc: www.metalroofingsystems.biz/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Counterflashings:
 - 1. ATAS International, Inc: www.atas.com/#sle.
 - 2. Hickman Edge Systems: www.hickmanedgesystems.com/#sle.
 - 3. Metal-Era Inc: www.metalera.com/#sle.

2.02 COMPONENTS

- A. Roof Edge Flashings: Factory fabricated to sizes required; corners mitered; concealed fasteners.
 - 1. Configuration: Fascia, cant, and edge securement for roof membrane.
 - 2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test methods RE-1 and RE-2 to positive and negative design wind pressure as defined by applicable local building code.
 - 3. Exposed Face Height: As indicated on drawings.
 - 4. Material: Formed aluminum sheet, 0.050 inch thick, minimum.
 - 5. Finish: 70 percent polyvinylidene fluoride (PVDF).
 - 6. Color: As selected by Architect from manufacturer's standard range.
- B. Copings: Factory fabricated to sizes required; corners mitered; concealed fasteners.
 - 1. Configuration: Concealed continuous hold down cleat at both legs; internal splice piece at joints of same material, thickness, and finish as cap; concealed stainless steel fasteners.
 - 2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-3 to positive and negative design wind pressure as defined by applicable local building code.
 - 3. Wall Width: As indicated on drawings.
 - 4. Outside Face Height: As indicated on drawings.
 - 5. Inside Face Height: As indicated on drawings.
 - 6. Material: Formed aluminum sheet, 0.050 inch thick, minimum.
 - 7. Color: As selected by Architect from manufacturer's standard range.
- C. Roof Penetration Sealing Systems: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- D. Counterflashings: Factory fabricated and finished sheet metal that overlaps top edges of base flashing by at least 4 inches, and designed to snap into through-wall flashing or reglets with lapped joints.
 - 1. Material: Formed aluminum sheet, 0.032 inch thick, minimum.
 - 2. Color: To be selected by Architect from manufacturer's standard range.

2.03 FINISHES

- A. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as indicated.

2.04 ACCESSORIES

- A. Sealant for Joints in Linear Components: As recommended by component manufacturer.
- B. Adhesive for Anchoring to Roof Membrane: Compatible with roof membrane and approved by roof membrane manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
- B. Seal joints within components when required by component manufacturer.
- C. Anchor components securely.
- D. Coordinate installation of components of this section with installation of roofing membrane and base flashings.
- E. Coordinate installation of sealants and roofing cement with work of this section to ensure water tightness.

SECTION 078400

FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

- A. {RSTEMP#1152}ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems{CH#46228}.
- B. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- C. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems.
- D. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
- E. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus.
- F. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies.
- G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- H. FM 4991 - Approval Standard of Firestop Contractors.
- I. FM (AG) - FM Approval Guide.
- J. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems.
- K. UL (DIR) - Online Certifications Directory.

1.04 SUBMITTALS

- A. See Section 013300 - Administrative Requirements for submittal procedures.
- B. Schedule of Firestopping: Project specific list each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Product Data: Provide data on product characteristics, performance ratings, and limitations.

- D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Certificate from authority having jurisdiction indicating approval of materials used.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
 - 1. Trained by manufacturer.
 - 2. Approved by Factory Mutual Research Corporation under FM 4991, or meeting any two of the following requirements:
 - a. Verification of minimum 10 years documented experience installing work of this type.
 - b. Verification of at least ten satisfactorily completed projects of comparable size and type.
 - c. Licensed by local authorities having jurisdiction (AHJ).

1.06 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Firestopping Manufacturers:
 - 1. Campus Standard is Hilti, Inc: www.hilti.com/#sle.

2.02 MATERIALS

- A. Firestopping Materials: Any materials meeting requirements.
- B. Mold and Mildew Resistance: Provide firestopping materials with mold and mildew resistance rating of zero(0) in accordance with ASTM G21.

- C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- D. Fire Ratings: Refer to drawings for required systems and ratings.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
 - 2. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
 - 3. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
 - 4. Where floor assembly is not required to have a fire rating, provide systems that have been tested to show L Rating as indicated.
- B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
- C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
 - 1. Movement: Provide systems that have been tested to show movement capability as indicated.
 - 2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
 - 3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
 - 4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.
- D. Through Penetration Firestopping: Use system that has been tested according to {RS#1152} to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 - 1. Temperature Rise: Provide systems that have been tested to show T Rating as indicated.
 - 2. Air Leakage: Provide systems that have been tested to show L Rating as indicated.
 - 3. Watertightness: Provide systems that have been tested to show W Rating as indicated.
 - 4. Listing by FM (AG), ITS (DIR), UL (DIR), or UL (FRD) in their certification directories will be considered evidence of successful testing.

2.04 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
 - 1. Fire Ratings: See drawings for required systems and ratings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.
- C. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- D. Install labeling required by code.

3.04 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.
- B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

SECTION 079200

JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.

1.03 REFERENCE STANDARDS

- A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- E. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants.
- F. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
- G. SCAQMD 1168 - Adhesive and Sealant Applications.

1.04 PREINSTALLATION CONFERENCE

- A. Discuss schedule; sequence; coordination of trades; substrate review and acceptance; protection; shop drawings and submittal; interface conditions and details; environmental constraints; mockups; testing requirements; field quality control efforts.
- B. Attendees: Installers of building components adjacent to sealant joints, installer of sealants,

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.

3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 4. Substrates the product should not be used on.
 5. Substrates for which use of primer is required.
 6. Manufacturers' installation instructions, including precautions, limitations, and recommended backing materials and tools.
 7. Sample product warranty.
 8. Certification by manufacturer indicating that product complies with specification requirements.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- E. Samples for Verification: Where custom sealant color is specified, obtain directions from Architect and submit at least two physical samples for verification of color of each required sealant.
- F. Installation Plan: Submit at least four weeks prior to start of installation.
- G. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
- H. Installation Log: Submit filled-out log for each length or instance of sealant installed.
- I. Manufacturer's qualification statement.
- J. Installer's qualification statement.
- K. Executed warranty.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and with at least five years of documented experience.
- D. Installation Plan: Include schedule of sealed joints, including the following:
1. Joint width indicated in Contract Documents.
 2. Joint depth indicated in Contract Documents; to face of backing material at centerline of joint.
 3. Method to be used to protect adjacent surfaces from sealant droppings and smears, with acknowledgment that some surfaces cannot be cleaned to like-new condition and therefore prevention is imperative.
 4. Approximate date of installation, for evaluation of thermal movement influence.
 5. Installation Log Form: Include the following data fields, with known information filled out.
 - a. Unique identification of each length or instance of sealant installed.
 - b. Location on project.
 - c. Substrates.
 - d. Sealant used.

- e. Stated movement capability of sealant.
 - f. Primer to be used, or indicate no primer is used.
 - g. Size and actual backing material used.
 - h. Date of installation.
 - i. Name of installer.
 - j. Actual joint width; provide space to indicate maximum and minimum width.
 - k. Actual joint depth to face of backing material at centerline of joint.
 - l. Air temperature.
- E. Field Quality Control Plan:
- 1. Visual inspection of entire length of sealant joints.
 - 2. Nondestructive field adhesion testing of sealant joints, except interior acrylic latex sealants.
 - 3. Field testing agency's qualifications.
 - 4. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.
- F. Field Adhesion Test Procedures:
- 1. Allow sealants to fully cure as recommended by manufacturer before testing.
 - 2. Have a copy of the test method document available during tests.
 - 3. Take photographs or make video records of each test, with joint identification provided in the photos/videos; for example, provide small erasable whiteboard positioned next to joint.
 - 4. Record the type of failure that occurred, other information required by test method, and the information required on the Field Quality Control Log.
 - 5. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.
- G. Nondestructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Spot Method.
- 1. Record results on Field Quality Control Log.
 - 2. Repair failed portions of joints.
- H. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or another applicable method as recommended by manufacturer.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.
- C. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

A. Scope:

1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to:
 - a. Precast architectural concrete wall panels.
 - b. Wall expansion and control joints.
 - c. Joints between door, window, and other frames and adjacent construction.
 - d. Joints between different exposed materials.
 - e. Other joints indicated below.
2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 - 1) Exception: Through-penetrations in sound-rated assemblies that are also fire-rated.
 - c. Other joints indicated below.
3. Do not seal the following types of joints:
 - a. Intentional weep holes in masonry.
 - b. Joints indicated to be treated with manufactured expansion joint cover, or some other type of sealing device.
 - c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
 - d. Joints where installation of sealant is specified in another section.
 - e. Joints between suspended panel ceilings/grid and walls.

B. Exterior Joints: Use nonsag nonstaining silicone sealant, unless otherwise indicated.

C. Interior Joints: Use nonsag polyurethane sealant, unless otherwise indicated.

D. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.02 JOINT SEALANTS - GENERAL

A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.

2.03 NONSAG JOINT SEALANTS

A. Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.

1. Movement Capability: Plus 100 percent and minus 50 percent, minimum.
2. Nonstaining to Porous Concrete and Stone: Nonstaining to light-colored precast and stone products when tested in accordance with ASTM C1248.
3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
4. Hardness Range: 15 to 35, Shore A, when tested in accordance with ASTM C661.

5. Color: To be selected by Architect from manufacturer's standard range.
 6. Service Temperature Range: Minus 20 to 180 degrees F.
 7. Products:
 - a. Tremco Commercial Sealants & Waterproofing; Spectrem 1:
www.tremcosealants.com/#sle.
- B. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus 100 percent, minus 50 percent, minimum.
 2. Hardness Range: 35 to 45, Shore A, when tested in accordance with ASTM C661.
 3. Color: To be selected by Architect from manufacturer's standard range.
 4. Service Temperature Range: Minus 40 to 180 degrees F.
 5. Products:
 - a. Tremco Commercial Sealants & Waterproofing; Dymonic 100:
www.tremcosealants.com/#sle.

2.04 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
1. Type for Joints Not Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type O - Open Cell Polyurethane.
 2. Type for Joints Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

- E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in an inconspicuous area to verify that it does not stain or discolor slab.

3.03 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.
- C. Install acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- C. Non-Destructive Adhesion Testing: If there are any failures in first 100 linear feet, notify Architect immediately.
- D. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

SECTION 081213
HOLLOW METAL FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated hollow metal frames for non-hollow metal doors.
- B. Fire-rated hollow metal frames for non-hollow metal doors.
- C. Interior glazed borrowed lite frames.

1.02 RELATED REQUIREMENTS

- A. Section 081416 - Flush Wood Doors: Non-hollow metal door for hollow metal frames.
- B. Section 087100 - Door Hardware: Hardware, silencers, and weatherstripping.
- C. Section 088000 - Glazing: Glazed borrowed lites.
- D. Section 099000 - Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS

- A. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for Windows, Doors, and Skylights.
- B. ADA Standards - 2010 ADA Standards for Accessible Design.
- C. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors.
- D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100).
- E. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- G. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.
- H. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- I. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities.
- K. ITS (DIR) - Directory of Listed Products.

- L. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames.
- M. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames.
- N. NAAMM HMMA 840 - Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames.
- O. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames.
- P. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
- Q. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames.
- R. UL (DIR) - Online Certifications Directory.
- S. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
- D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide hollow metal frames from SDI Certified manufacturer: <https://steeldoor.org/sdi-certified/#sle>.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with applicable requirements and in compliance with standards and/or custom guidelines as indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 3. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
 - 4. Steelcraft, an Allegion brand: www.allegion.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

- A. Hollow Metal Frames: AAMA/WDMA/CSA 101/I.S.2/A440 requirements for specific frame type:
 - 1. Performance Class (PC): CW.
- B. Door Frame Type: Provide hollow metal door frames with integral casings.
 - 1. Interior Doors: Use frames with integral casings.
- C. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
- D. Accessibility: Comply with ICC A117.1 and ADA Standards.
- E. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings. Style: Manufacturers standard.
- F. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior frame that is also indicated as being sound-rated must comply with the requirements specified for exterior frames and for sound-rated frames; where two requirements conflict, comply with the most stringent.
- G. Hardware Preparations, Selections and Locations: Comply with BHMA A156.115, NAAMM HMMA 830, NAAMM HMMA 831 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- H. Frames for Interior Glazing or Borrowed Lites: Construction and face dimensions to match door frames, and as indicated on drawings.
- I. Frames Wider than 48 Inches: Reinforce with steel channel fitted tightly into head of frame, and flush with top.

2.03 HOLLOW METAL DOOR FRAMES WITH INTEGRAL CASINGS

- A. Frame Finish: Factory primed and field finished.
- B. Interior Door Frames, Non-Fire Rated: Face welded type.
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
- C. Fire-Rated Door Frames: Face welded type.
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - 2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C or NFPA 252 ("positive pressure fire tests").
 - 3. Provide units listed and labeled by ITS (DIR) or UL (DIR).

- a. Attach fire rating label to each fire rated unit.

2.04 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.05 ACCESSORIES

- A. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 INSTALLATION

- A. Install frames in accordance with manufacturer's instructions and related requirements of specified frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Comply with glazing installation requirements of Section 088000.
- E. Install door hardware as specified in Section 087100.
- F. Coordinate installation of electrical connections to electrical hardware items.

3.03 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch measured with straight edges, crossed corner to corner.

SECTION 081416
FLUSH WOOD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush wood doors; flush and flush glazed configuration; fire-rated and non-rated.

1.02 RELATED REQUIREMENTS

- A. Section 081213 - Hollow Metal Frames.
- B. Section 087100 - Door Hardware.
- C. Section 088000 - Glazing.

1.03 REFERENCE STANDARDS

- A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- B. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.
- E. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.
- F. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
- G. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.
- H. WDMA I.S. 1A - Interior Architectural Wood Flush Doors.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate door core materials and construction.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
- D. Samples: Submit two samples of door finish materials, 12 by 12 inches in size illustrating facing material.
- E. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- F. Test Reports: Show compliance with specified requirements for the following:

1. Sound-retardant doors and frames; sealed panel tests are not acceptable.
- G. Manufacturer's qualification statement.
- H. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging, and inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach finish; seal top and bottom edges if stored more than one week, and break seal on site to permit ventilation.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer's warranty on interior doors for the life of the installation. Complete forms in Owner's name and register with manufacturer.
 1. Include coverage for warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. PETG PVC-Free Sheet Faced Doors:
 1. Construction Specialties, Inc; Acrovyn Flush Doors: www.c-sgroup.com/#sle.
 2. Substitutions: See Section 016000 - Product Requirements.

2.02 DOORS

- A. Doors: See drawings for locations and additional requirements.
 1. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS), AWMAC/WI (NAAWS) or WDMA I.S. 1A.
 2. Acrylic-Modified Vinyl Faced Doors:
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 1. Provide solid core doors at each location.
 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.

2.03 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.
- B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.

2.04 DOOR FACINGS

- A. Acrylic-Modified PVC Facing: Manufacturer's standard formulation.
 - 1. Thickness: 0.040 inch.
 - 2. Color and Pattern: As indicated on drawings.
 - 3. Texture: As selected from manufacturer's standard textures.
 - 4. Mounting: Adhesive.
 - 5. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 55 or less, when tested in accordance with ASTM E84.
 - 6. Impact Strength: 18 ft lbf/in minimum, when tested in accordance with ASTM D256.
 - 7. Chemical and Stain Resistance: No visible staining or discoloration and no damage to surface texture when tested in accordance with ASTM D1308.

2.05 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 - 1. Provide solid blocks at lock edge and top of door for closer for hardware reinforcement.
 - 2. Provide solid blocking for other throughbolted hardware.
- C. Where supplementary protective edge trim is required, install trim after veneer facing has been applied full-width.
- D. Glazed Openings: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
- E. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- F. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- G. Provide edge clearances in accordance with the quality standard specified.

2.06 ACCESSORIES

- A. Hollow Metal Door Frames: See Section 081113.
- B. Metal Louvers:
 - 1. Material and Finish: Roll formed steel; pre-painted finish to color as selected.
 - 2. Louver Blade: Inverted V blade, sight proof.
- C. Door Window Frames: Door window frames with glazing securely fastened within door opening.

- D. Glazing: See Section 088000.
- E. Glazing Stops: Rolled steel channel shape, mitered corners; prepared for countersink style screws.
- F. Astragals and Edges for Double Doors: Pairs of doors astragals, and door edge sealing and protection devices.
- G. Door Hardware: See Section 087100.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Coordinate installation of glazing.
- F. Install door louvers plumb and level.

3.03 TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

SECTION 083100
ACCESS DOORS AND PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall-mounted access units.

1.02 RELATED REQUIREMENTS

- A. Section 099000 - Painting and Coating: Field paint finish.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

- A. See Section 013300 - Submittal Procedures for submittal procedures.
- B. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- C. Shop Drawings: Indicate exact position of each access door and/or panel unit.
- D. Manufacturer's Installation Instructions: Indicate installation requirements.
- E. Project Record Documents: Record actual locations of each access unit.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

- A. Wall-Mounted Units:
 - 1. Location: As indicated on drawings.
 - 2. Panel Material: Aluminum extrusions with gypsum board inlay.
 - 3. Size: Minimum 12 by 12 inches or as required by components requiring access.
 - 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 - 5. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
 - 6. Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface recessed for infill with wall finish.
- B. Wall-Mounted Units in Wet Areas:
 - 1. Location: As indicated on drawings.

2. Panel Material: Aluminum.
 3. Size: Minimum 12 by 12 inches or as required by components requiring access.
 4. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
 5. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
- C. Fire-Rated Wall-Mounted Units:
1. Location: As indicated on drawings.
 2. Wall Fire-Rating: As indicated on drawings.
 3. Panel Material: Steel.
 4. Size: Minimum 12 by 12 inches or as required by components requiring access.
 5. Door/Panel: Insulated double-surface panel, with tool-operated spring or cam lock and no handle.
- D. Ceiling-Mounted Units:
1. Location: As indicated on drawings.
 2. Panel Material: Aluminum extrusion with gypsum board inlay.
 3. Size - Lay-In Grid Ceilings: To match module of ceiling grid.
 4. Size - Other Ceilings: 12 by 12 inches.
 5. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings are correctly sized and located.
- B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to proceeding with this work.
- B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.
- C. Position units to provide convenient access to concealed equipment when necessary.

SECTION 084243

INTENSIVE CARE UNIT / CRITICAL CARE UNIT ENTRANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Packaged units consisting of doors, sidelights, frames, and hardware; manual operation.

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants: Sealing joints between door frames and adjacent construction.
- B. Section 088836.16 - Electronically Controlled Switchable Glass
- C. Section 088000 - Glazing.

1.03 DEFINITIONS

- A. SX Panel: Sliding panel that swings open upon pushing.
- B. SO Panel: Sidelight panel, normally stationary, that will swing open upon pushing.
- C. X Panel: Sliding panel unable to swing.
- D. O Panel: Sidelight panel unable to swing.

1.04 REFERENCE STANDARDS

- A. AAMA 611 - Specification for Anodized Architectural Aluminum.
- B. ADA Standards - 2010 ADA Standards for Accessible Design.
- C. ITS (DIR) - Directory of Listed Products.
- D. NAAMM AMP 500-06 - Metal Finishes Manual.
- E. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives.
- F. UL (DIR) - Online Certifications Directory.
- G. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Meeting: Convene one week before starting work of this section.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's catalog data, detail sheets, and specifications, including:
 - 1. Preparation instructions and recommendations.

- 2. Storage and handling requirements and recommendations.
- 3. Installation methods.
- 4. Specimen warranty.
- C. Shop Drawings: Prepared specifically for this project; show dimensions of doors, sidelights, details of construction, and interface with other products.
- D. Samples: Two samples, each minimum size 6 inches square, showing actual product, color, and patterns for each finish product specified.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Operating and Maintenance Data: Operating and maintenance instructions, and parts lists.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Deliver products to project site in factory packaging, protected from damage.
- C. Store products in manufacturer's unopened packaging until ready for installation.
- D. Store products under cover and elevated above grade.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide one-year manufacturer warranty. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manually-Operated ICU/CCU Entrance Door Assemblies:
 - 1. ASSA ABLOY Entrance Solutions; Besam VersaMax ICU Telescopic: www.besam-usa.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Provide ICU/CCU entrances from a single manufacturer.

2.02 ENTRANCE DOOR ASSEMBLIES

- A. Entrance Assemblies: Factory assembled, manually-operated, extruded aluminum door and frame with normally-closed but operable sidelights, complete with hardware and operating components.
1. Door and Sidelight Construction: Heavy duty interlocked extruded aluminum tubular stile and rail sections, through-rod bolted construction with steel corner support at hinge stile of carrier-suspended swinging panels to reduce sag in sliding or breakout mode.
 - a. Door Thickness: 1-3/4 inch, nominal.
 2. Accessible Door Opening Force: Maximum of 5 pound-force to fully open door in compliance with ADA Standards and requirements of local authorities having jurisdiction.
 3. Panel Breakout Force: Maximum of 50 pound-force.
 4. Air Leakage: Provide entrance assemblies for smoke control that are ITS (DIR) or UL (DIR) listed and labeled and acceptable to authorities having jurisdiction based on testing in accordance with UL 1784 and having maximum air leakage in compliance with NFPA 105 unless otherwise indicated.
 5. Finish: Clear anodized, AAMA 611 Class I; in compliance with NAAMM AMP 500-06.
 - a. Color: As selected by Architect.
 6. Antimicrobial Finish: Provide EPA-approved silver-based antimicrobial coating on exposed metal parts, including door handles.
- B. Dimensions:
1. Rough Opening Width: As indicated on drawings.
 2. Overall Frame Width (Outside): As indicated on drawings.
 3. Clear Opening Width: As indicated on drawings, when swinging panels are fully open.
 4. Normal Operation Opening Width: As indicated on drawings.
 5. Maximum Panel Width: As indicated on drawings.
 6. Rough Opening Height: As indicated on drawings.
 7. Overall Frame Height: As indicated on drawings.
 8. Clear Door Opening Height: As indicated on drawings.
 9. Framing Members: Provide manufacturer's standard extruded aluminum framing, reinforced as required to support imposed loads.
 - a. Nominal Sizes: 1-3/4 inch wide by 4-1/2 inch deep.
 - b. Concealed Fastening: Provide concealed fastening pocket in framing, with continuous flush insert cover extending full length of each framing member.
 10. Panel Thickness: 1-3/4 inch.
 11. Stile Design:
 - a. Narrow stile, 2 inch, nominal width.
 12. Top Rail Height: 4 inch, nominal.
 13. Bottom Rail Height: 10 inch, nominal.
 14. Glazing Stop Width: Manufacturers standard.
 15. Glazing Thickness: 9/16 inch.
- C. Full Width Breakout Type Sliding Entrances: Normal operation consisting of side-sliding panel passing sidelight(s); panels along with sidelights have breakout function; sliding panels passing on non-swinging side of sidelight.
1. Panels: Three; each telescoping.
 2. Swing Direction: Panels to swing out into corridor for main patient room entry doors and into patient room at patient toilet rooms.
 3. Track: No floor track in normal operation opening; recessed door guide track permitted in remainder of opening.

2.03 COMPONENTS

- A. Aluminum Extrusions for Doors, Sidelights, Headers, and Trim: Alloy as recommended by manufacturer for construction and specified finish; nominal 1/8 inch wall thickness.
- B. Sliding Door Header: Track and suspension system concealed with removable cover.
 - 1. Track: Extruded aluminum, with anti-rising, anti-derailing design.
 - 2. Door Suspension System: Two wheeled carriers per panel, with steel ball bearings; wheel diameter minimum 1-1/4 inch.
 - 3. Door Hanger Brackets: Nylon wheels with hardened steel bearings.
- C. Breakout Mechanism: 90 degree swing from any position in sliding cycle, released under not more than 50 pounds-force pressure at strike stile of panel, with sufficient strength to support weight of panels without drooping or racking.
 - 1. Swing Control: Spring-loaded stainless steel ball detent latch.
 - 2. Provide entrance units having UL (DIR) or ITS (DIR) listed exitway.
- D. Glazing Stops: Manufacturer's standard snap-on extruded aluminum square stops with preformed resilient glazing gaskets.
- E. Door Hardware: Provide door handles, active leaf with positive latch, and other hardware as required for normal and swing-open operation; factory install hardware to greatest extent possible.
- F. Glazing: See Section 088836.16.
- G. Sealant for Within Door/Frame Assembly: As recommended or required by door manufacturer.
- H. Sealant for Setting Surfaces of Mounted Tracks: Provide traffic-grade polyurethane, refer to Section 079200 for additional requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that openings are plumb, square, and ready for installation of entrances.
- B. Verify that overhead support is properly located and securely anchored.
- C. Verify that floor is properly prepared to receive recessed door guide track.
- D. Do not begin installation until substrates have been properly prepared.
- E. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Where aluminum components will contact different metals, prior to installation paint contact surfaces with primer or apply sealant or tape recommended by manufacturer for protection against galvanic action.

- D. Where aluminum components will contact concrete or masonry, prior to installation paint contact surfaces with bituminous paint.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions, except where more stringent requirements are specified.
- B. Install entrances securely anchored in place, plumb, level, and true to location, in alignment with established lines and grades, without warp, bow, or racking of members.
- C. Where frames are assembled in field, fit frame joints hairline tight without burrs or distortion; rigidly secure nonmoving joints and seal watertight.
- D. Install floor track recessed in floor, with top flush with finished floor surface.
 - 1. Fill and level floor recess and properly set track at floor.
- E. Install field-installed hardware using concealed fasteners to greatest extent possible.
- F. Install glazing in accordance with requirements of Section 088000.

3.04 ADJUSTING

- A. Adjust entrances for correct function and smooth operation, without binding or scraping and without excessive noise; lubricate operating hardware and other moving parts.

3.05 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove temporary protection; clean exposed surfaces.

3.06 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for additional submittals.
- B. Demonstration: Demonstrate operation of equipment to Owner's designated personnel.

3.07 PROTECTION

- A. Protect installed products until Date of Substantial Completion.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

SECTION 084313
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors and frames.

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.
- B. Section 084413 - Glazed Aluminum Curtain Walls.
- C. Section 087100 - Door Hardware: Hardware items other than specified in this section.
- D. Section 088000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site.
- B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.
- C. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
- D. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document).
- E. AAMA 611 - Specification for Anodized Architectural Aluminum.
- F. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
- G. {RSTEMP#311}ASCE 7 - Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers{CH#51483}.
- H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- I. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- J. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- K. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

- L. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- M. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
- N. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.
 - 1. Review schedule, coordination of trades, substrate review and acceptance, protection, submittals, complex interfaces and details, environmental constraints, mockups, testing, quality control.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details. Include manufacturer's installation instructions.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, assembly expansion and contraction joint location and details, and field welding required.
- D. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- E. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Specimen warranty.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.
 - 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
 - a. Insulating Glass Certification Council (IGCC).
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.
 - 1. Provide company, field supervisors, and installers that hold active ANSI accredited certifications in appropriate categories for work specified.
 - a. North American Contractor Certification (NACC) for glazing contractors.

- b. Equivalent independent third-party ANSI accredited certification.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide 20 year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aluminum-Framed Storefronts:
 - 1. Kawneer North America: Basis of Design: TriFab 451T (exterior) and TriFab 451 (interior) www.kawneer.com/#sle.

2.02 ALUMINUM-FRAMED STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related anchorage and attachment devices.
 - 1. Glazing Rabbet: For 1 inch insulating glazing.
 - 2. Glazing Rabbet: For 1/4 inch monolithic glazing.
 - 3. Glazing Position: Centered (front to back).
 - 4. Finish: Class II natural anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 - 5. Finish Color: As selected by Architect from manufacturer's standard line.
 - 6. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 7. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.

8. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 9. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
 10. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
 11. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
 12. Maintain continuous air barrier and/or vapor retarder seal throughout assembly, primarily in line with inside pane of glazing, and heel bead of glazing compound.
- B. Performance Requirements
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Design Wind Loads: Comply with requirements of ASCE 7.
 - b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
 2. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8 psf.
 3. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.
 4. Condensation Resistance Factor of Framing: 50, minimum, measured in accordance with AAMA 1503.

2.03 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.
1. Framing members for interior applications need not be thermally broken; exterior systems to be thermally broken.
 2. Glazing Stops: Flush.
 3. Cross-Section: As indicated on drawings.
- B. Glazing: See Section 088000.
- C. Swing Doors: Glazed aluminum.
1. Thickness: 1-3/4 inches.
 2. Top Rail: 4 inches wide.
 3. Vertical Stiles: 4-1/2 inches wide.
 4. Bottom Rail: 10 inches wide.
 5. Glazing Stops: Square.
 6. Finish: Same as storefront.

2.04 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Fasteners: Stainless steel.

- C. Exposed Flashings: Aluminum sheet, 20 gauge, 0.032 inch minimum thickness; finish to match framing members.
- D. Concealed Flashings: Sheet aluminum, 26 gauge, 0.017 inch minimum thickness.
- E. Sill Flashing Sealant: Elastomeric, silicone or polyurethane, compatible with flashing material.
- F. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- G. Glazing Accessories: See Section 088000.

2.05 FINISHES

- A. Class II Natural Anodized Finish: AAMA 611 AA-M12C22A31 Clear anodic coating not less than 0.4 mils thick.
 - 1. Location: Interior storefront glazing system.
- B. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.06 HARDWARE

- A. Other Door Hardware: See Section 087100.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that storefront wall openings and adjoining materials are ready to receive work of this section.
- C. Satisfactory conditions must be met prior to installation.
- D. Installation of storefront window indicates acceptance of substrate.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

- I. Install glass using glazing method required to achieve performance criteria; see Section 088000.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 FIELD QUALITY CONTROL

- A. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.
- B. Water-Spray Test: Provide water spray quality test of installed storefront components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as indicated on drawings.
 - 2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
- C. Provide field testing of installed storefront system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as indicated on drawings.
 - 2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
 - 3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf.
 - a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.
 - 4. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 6.20 psf.
 - a. Maximum allowable rate of air leakage is 0.06 cfm/sq ft.

3.05 ADJUSTING

- A. Adjust operating hardware for smooth operation.

3.06 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.
- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.07 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

SECTION 084413

GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed curtain wall, with vision glazing.
- B. Firestopping between curtain wall and edge of floor slab.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping: Firestop at system junction with structure.
- B. Section 088000 - Glazing.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site.
- B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.
- C. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems.
- D. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document).
- E. AAMA 611 - Specification for Anodized Architectural Aluminum.
- F. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
- G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- H. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- I. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
- J. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- K. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
- L. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details, glazing, and infill.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
- D. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- E. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.
- F. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- G. Designer's Qualification Statement.
- H. Manufacturer's Qualification Statement.
- I. Installer's Qualification Statement.
- J. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design curtain wall and its structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with not less than five years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with installer.
- C. Finish Warranty: Provide twenty year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Glazed Aluminum Curtain Walls Manufacturers:
 - 1. Kawneer North America: www.kawneer.com/#sle.
 - 2. YKK AP America, Inc: www.ykkap.com/commercial/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.

2.02 CURTAIN WALL

- A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Outside glazed, with pressure plate and mullion cover, where indicated on drawings.
 - 2. Fabrication Method: Field fabricated stick system.
 - 3. Glazing Method: Field glazed system.
 - 4. Vertical Mullion Face Width: 2-1/2 inches.
 - 5. Vertical Mullion Depth From Face of Glazing to Back of Frame: See drawings for system depth.
 - 6. Finish: Class II natural anodized.
 - a. Factory finish surfaces that will be exposed in completed assemblies.
 - b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 - 7. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 8. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 9. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - 10. Maintain continuous air barrier and/or vapor retarder seal throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel and heel bead of glazing compound.

11. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
- B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
 1. Design Wind Loads: Comply with project loads indicated and the applicable code.
 - a. Member Deflection: For spans less than 13 feet 6 inches, limit member deflection to flexure limit of glass in any direction, and maximum of 1/175 of span or 3/4 inch, whichever is less and with full recovery of glazing materials.
 - b. Member Deflection: For spans over 13 feet 6 inches and less than 40 feet, limit member deflection to flexure limit of glass in any direction, and maximum of 1/240 of span plus 1/4 inch, with full recovery of glazing materials.
 2. Movement: Accommodate the following movement without damage to components or deterioration of seals:
 - a. Expansion and contraction caused by 180 degrees F surface temperature.
 - b. Expansion and contraction caused by cycling temperature range of 170 degrees F over a 12 hour period.
 - c. Movement of curtain wall relative to perimeter framing.
 - d. Deflection of structural support framing, under permanent and dynamic loads.
- C. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on indoor face when tested as follows:
 1. Test Pressure Differential: 20 psf.
- D. Air Leakage: 0.06 cfm/sq ft maximum leakage of wall area when tested in accordance with ASTM E283/E283M at 6.24 psf pressure difference across assembly.
- E. Thermal Performance Requirements:
 1. Condensation Resistance Factor of Framing: 50, minimum, measured in accordance with AAMA 1503.

2.03 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 1. Cross-Section: As indicated on drawings.
- B. Glazing: See Section 088000.

2.04 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Fasteners: Stainless steel; type as required or recommended by curtain wall manufacturer.
- C. Exposed Flashings: Aluminum sheet, 20-gauge, 0.032-inch minimum thickness; finish to match framing members.
- D. Concealed Flashings: Sheet aluminum, 26-gauge, 0.017-inch minimum thickness.
- E. Firestopping: See Section 078400.
- F. Weatherseal Sealant: Silicone, with adhesion in compliance with ASTM C794; compatible with glazing accessories.

- G. Sill Flashing Sealant: Elastomeric, silicone or polyurethane, and compatible with flashing material.
- H. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- I. Glazing Accessories: See Section 088000.

2.05 FINISHES

- A. Class II Natural Anodized Finish: AAMA 611 AA-M12C22A31 Clear anodic coating not less than 0.4 mils thick.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other related work.
- B. Verify that curtain wall openings and adjoining water-resistive and air barrier seal materials are ready to receive work of this section.
- C. Verify that anchorage devices have been properly installed and located.

3.02 INSTALLATION

- A. Install curtain wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Install firestopping at each floor slab edge.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet noncumulative or 0.5 inches per 100 feet, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.
- C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.04 FIELD QUALITY CONTROL

- A. Provide services of curtain wall manufacturer's field representative to observe for proper installation of system and submit report.
- B. Water-Spray Test: Provide water spray quality test of installed curtain wall components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as directed by Architect.
 - 2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
- C. Provide field testing of installed curtain wall system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as indicated on drawings.
 - 2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
 - 3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf.
 - a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.
 - 4. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 1.57 psf.
 - a. Maximum allowable rate of air leakage is 0.09 cfm/sq ft.
- D. Repair or replace curtain wall components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.05 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, take care to remove dirt from corners, and wipe surfaces clean.
- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.06 PROTECTION

- A. Protect installed products from damage until Substantial Completion.

SECTION 08 71 00 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Commercial door hardware for the following:
 - a. Swinging doors.
 - b. Other doors to the extent indicated.
- B. Related Sections include the following:
 - 1. Division 8 Section "Steel Doors and Frames"
 - 2. Division 8 Section "Flush Wood Doors"
 - 3. Division 8 Section "Aluminum Entrances and Storefronts"
 - 4. Division 8 Section "Power Door Operators" for automatic door operators.

1.3 SUBMITTALS

- A. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Details of electrified door hardware, indicating the following:

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. System schematic.
 - b. Point-to-point wiring diagram.
 - c. Riser diagram.
 - d. Elevation of each door.
 2. Detail interface between electrified door hardware and access fire alarm, control, and security building control system.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of door hardware indicated.
1. Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.
- D. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
 - a. Organize door hardware sets in same order as in the Door Hardware Schedule at the end of Part 3.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.

- c. Fastenings and other pertinent information.
 - d. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
- 1) Sequence of Operation: Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.
- 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
 - 5. Submittal Sequence: Submit initial draft of final schedule along with essential Product Data to facilitate the fabrication of other work that is critical in the Project construction schedule. Submit the final Door Hardware Schedule after Samples, Product Data, coordination with Shop Drawings of other work, delivery schedules, and similar information has been completed and accepted.
- E. Keying Schedule: Prepared by or under the supervision of supplier, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.
 - F. Product Certificates: Signed by manufacturers of electrified door hardware certifying that products furnished comply with requirements.
 - 1. Certify that door hardware approved for use on types and sizes of labeled fire doors complies with listed fire door assemblies.
 - G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
 - 1. Include lists of completed projects with project names and addresses of architects and owners, and other information specified.

- H. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, indicating current products comply with requirements.
- I. Maintenance Data: For each type of door hardware to include in maintenance manuals specified in Division 1.
- J. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Supplier Qualifications: Door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 - 1. Electrified Door Hardware Supplier Qualifications: An experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.
 - a. Engineering Responsibility: Prepare data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- C. Architectural Hardware Consultant Qualifications: A person who is currently certified by the Door and Hardware Institute as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.
 - 1. Electrified Door Hardware Qualifications: Experienced in providing consulting services for electrified door hardware installations.
- D. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that are listed to perform electrical modifications, by a testing and inspecting agency acceptable to authorities having jurisdiction, are acceptable.
- E. Regulatory Requirements: Comply with provisions of the following:

1. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1, FED-STD-795, "Uniform Federal Accessibility Standards," as follows:
 - a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
 - b. Door Closers: Comply with the following maximum opening-force requirements indicated:
 - 1) Interior Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
 - 2) Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
 - 3) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - c. Thresholds: Not more than 1/2 inch (13 mm) high, Not more than 3/4 inch (19 mm) high for exterior sliding doors. Bevel raised thresholds with a slope of not more than 1:2.
 2. NFPA 101: Comply with the following for means of egress doors:
 - a. Latches, Locks, and Exit Devices: Not more than 15 lbf (67 N) to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
 - b. Delayed-Egress Locks: Lock releases within 15 seconds after applying a force not more than 15 lbf (67 N) for not more than 3 seconds.
 - c. Door Closers: Not more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.
 - d. Thresholds: Not more than 1/2 inch (13 mm) high.
 3. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- F. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
1. Test Pressure: Test at atmospheric pressure.
- G. Keying Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings." Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 2. Preliminary key system schematic diagram.
 3. Requirements for key control system.
 4. Address for delivery of keys.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."
- I. All Electric Door Hardware shall be furnished and installed by the General Contractor. All Electric Door Hardware shall be wired by the Electrical Contractor. Both the Electrical & General Contractor shall meet and coordinate all work before proceeding.
- J. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings." Review methods and procedures related to electrified door hardware including, but not limited to, the following:
1. Inspect and discuss electrical roughing-in and other preparatory work performed by other trades.
 2. Review sequence of operation for each type of electrified door hardware.
 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review required testing, inspecting, and certifying procedures.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item with Door Number related to the final Approved Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver keys to manufacturer of key control system, or Owner as Directed.
- D. Deliver keys to Owner by registered mail or overnight package service.
- 1.6 COORDINATION

- A. Coordinate layout and installation of recessed pivots and closers with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- B. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Electrical System Roughing-in: Coordinate layout and installation of electrified door hardware with connections to power supplies, fire alarm system and detection devices, access control system, security system, and building control system.

1.7 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of operators and door hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Warranty Period for Locksets: Ten, (10) years from date of Substantial Completion, unless otherwise indicated.
- D. Warranty Period for Manual Closers: Twenty Five, (25) years from date of Substantial Completion, unless otherwise indicated.
- E. Warranty Period for Exit Devices: Ten, (10) years from date of Substantial Completion, unless otherwise indicated.
- F. Warranty Period for Electrical Exit Devices: Two, (2) years from date of Substantial Completion, unless otherwise indicated.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies as used in the manufacture and installation of original products.
- C. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section, door hardware sets indicated in door and frame schedule, and the Door Hardware Schedule at the end of Part 3.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturer's products. Retain subparagraph below for electrified door hardware.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Schedule at the end of Part 3. Products are identified by using door hardware designations, as follows:
 - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

2.2 HINGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Butt Hinges:
 - a. Best Hinge Company, Inc.
 - b. Hager Hinge Company, Inc.
- B. Standards: Comply with the following:
 1. Hinges ANSI/BHMA Standard A156.1 Grade 1
- C. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- D. Concealed bearings are made from engineered polymer material with PTFE and Aramid fiber; bearing is maintenance free, no oil, no grease.
- E. Butt hinges equipped with easily seated, non-rising pin. Hole in bottom of pin enables quick pin removal for ease of installation.
- F. Hinge Base Metal: Unless otherwise indicated, provide the following:
 1. Interior Butt Hinges: Steel or Brass or Bronze
- G. Hinge Options: Comply with the following where indicated in the Door Hardware Schedule or on Drawings:
 1. Hospital Tips: Slope ends of hinge barrel.
 2. Maximum Security Pin: Fix pin in hinge barrel after it is inserted.
 3. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:

- a. Outswinging exterior doors.
- b. Outswinging corridor doors with locks.

H. Fasteners: Comply with the following:

- 1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
- 2. Wood Screws: For wood doors and frames.
- 3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
- 4. Screws: Phillips flat-head screws; machine screws drilled and tapped holes for metal doors, wood screws for wood doors and frames. Finish screw heads to match surface of hinges.

2.3 LOCKS AND LATCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Mechanical Locks and Latches:
 - a. Best Locking Systems, Inc. TUH Standard

B. Standards: Comply with the following:

- 1. Bored Locks and Latches: BHMA A156.2.
- 2. Mortise Locks and Latches: BHMA A156.13.

C. Bored Locks: ANSI A156.2, BHMA Series 4000, Grade 1, and is UL Listed.

D. Mortise Locks: Stamped steel case with steel or brass parts; ANSI A156.13, Series 1000, BHMA Grade 1 Operational and Grade 2 Security and be UL Listed.

E. Certified Products: Provide door hardware listed in the following BHMA directories:

- 1. Mechanical Locks and Latches: BHMA's "Directory of Certified Locks & Latches."
- 2. Electromagnetic Locks: BHMA's "Directory of Certified Electromagnetic & Delayed Egress Locks."

F. Lock Trim: Comply with the following:

1. Lever: Mortise Locks & Latches, Forged or Cast brass, bronze or stainless steel construction
 2. Lever: Cylindrical Locks & Latches, Zinc material with a minimum wall thickness of .060
 3. Dummy Trim: Match lever lock trim and escutcheons.
- G. Lock Functions: Function numbers and descriptions indicated in the Door Hardware Schedule comply with the following:
1. Bored Locks: BHMA A156.2.
 2. Mortise Locks: BHMA A156.13.
- H. Lock Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:
1. Bored Locks: Minimum 9/16-inch latch bolt throw.
 2. Mortise Locks: Minimum 3/4-inch latch bolt throw.
 3. Deadbolts: Minimum 1-inch bolt throw.
- I. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
- J. Mortise Locks & Latches shall have an anti-friction, 3/4-inch throw latch bolt with anti-friction piece made of self-lubricated stainless steel. Latch bolt with plastic insert and three-piece latch bolt are unacceptable on this project.
- K. Mortise Locks & Latches shall have levers to be operated with a roller bearing spindle hub mechanism.
- L. Cylindrical Locks & Latches to have solid shank with no opening for access to keyed lever keeper.
- 2.4 DOOR BOLTS
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flush Bolts:
 - a. Architectural Builders Hardware, Inc.
 - b. Hager Company, Inc.

B. Standards: Comply with the following:

1. Automatic and Self-Latching Flush Bolts: BHMA A156.3.
2. Manual Flush Bolts: BHMA A156.16.

C. Flush Bolts: BHMA Grade 1, designed for mortising into door edge.

D. Bolt Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Mortise Flush Bolts: Minimum 3/4-inch (19-mm) throw.

2.5 EXIT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allegion / Von Duprin, Inc.

B. Standard: BHMA A156.3.

1. BHMA Grade: Grade 1

C. Certified Products: Provide exit devices listed in BHMA's "Directory of Certified Exit Devices."

D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

E. Fire Exit Devices: Complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

- F. Exit device shall be "touch pad" type with a touch pad that shall extend a minimum of one half (1/2) of the door width.
- G. Exit device lock stile chassis shall be investment cast steel. Stamped steel units will not be accepted. All device latch bolts shall be stainless steel and shall be deadlocking type.
- H. Exit device strikes shall be adjustable type investment cast stainless steel.
- I. Exit device shall include sound reduction dampening for both depression and extension of the touch pad.
- J. Exit device end cap shall be all metal and secured with a bracket that interlocks both at the touch bar channel base and hinge side filler to prevent end cap "peel-back".
- K. All exposed surfaces of the exit device housing shall be no less than 14 gauge brass or bronze; or no less than 16 gauge stainless steel. Aluminum housing type exit devices are not acceptable.
- L. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 - 1. Operation: Rigid
- M. Outside Trim: Lever, Lever with cylinder, Pull, Pull with cylinder, material and finish to match locksets, unless otherwise indicated.
 - 1. Match design for locksets and latchsets, unless otherwise indicated.

2.6 CYLINDERS AND KEYING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cylinders:
 - a. Best Locking Systems, Inc. TUH Standard
 - b. All cylinders shall be 7-pin interchangeable cores.
- B. Standards: Comply with the following:
 - 1. Cylinders: BHMA A156.5.

- C. Cylinder Grade: BHMA Grade 1, Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
 - 1. Number of Pins: Seven.
 - 2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 - 3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 4. Bored-Lock Type: Cylinders with tailpieces to suit locks.
- D. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's locksets.
- E. Construction Keying: Comply with the following:
 - 1. Construction Cores: Provide Brass construction cores in all locksets and cylinders that are replaceable by permanent cores.
 - a. Replace Brass construction cores with permanent cores, as indicated in keying schedule
- F. Keying System: Unless otherwise indicated, provide a factory-registered keying system complying with the following requirements:
 - 1. Existing System: Master key or grand master key locks to Owner's existing system.
- G. Keys: Provide nickel-silver keys complying with the following:
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."

2. Quantity: In addition to one extra blank key for each lock, provide the following:

- a. Cylinder Change Keys: Three.
- b. Master Keys: Five.
- c. Grand Master Keys: Five.
- d. Great-Grand Master Keys: Five.
- e. Control Keys: Five
- f. Construction Master Keys: Ten
- g. Construction Core Control Keys: Five

2.7 STRIKES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Electric Strikes:

- a. HES Manufacturing, Inc.

B. Standards: Comply with the following:

- 1. Strikes for Bored Locks and Latches: BHMA A156.2.
- 2. Strikes for Mortise Locks and Latches: BHMA A156.13.
- 3. Electric Strikes: BHMA A156.5.

C. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

- 1. Flat-Lip Strikes: For locks with three-piece antifriction latch bolts, as recommended by manufacturer.
- 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
- 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

D. Dustproof Strikes: BHMA Grade 1

E. Electric Strikes: BHMA Grade 1

- F. according to UL 305 and NFPA 252. Mullions shall be used only with exit devices for which they have been tested.

2.8 CLOSERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Surface-Mounted Closers:
 - a. Allegion / LCN, Inc.
- B. Standards: Comply with the following:
 - 1. Closers: BHMA A156.4.
- C. Surface Closers: BHMA Grade 1
- D. Certified Products: Provide door closers listed in BHMA's "Directory of Certified Door Closers."
- E. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.9 PROTECTIVE TRIM UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Metal Protective Trim Units:
 - a. Architectural Builders Hardware, Inc.
 - b. Assa Abloy / Rockwood, Inc.
- B. Standard: Comply with BHMA A156.6.
- C. Materials: Fabricate protection plates from the following:
 1. Stainless Steel: 0.050 inch (1.3 mm) thick; beveled 4 sides.
- D. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine or self-tapping screws.
- E. Furnish protection plates sized 2" less than door width on push side and 1" less than door width on pull side, by height specified in Door Hardware Schedule.

2.10 STOPS AND HOLDERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Allegion / Glynn Johnson, Inc.
- B. Standards: Comply with the following:
 1. Combination Overhead Holders and Stops: BHMA A156.8.
- C. Combination Overhead Stops and Holders: BHMA Grade 1
- D. inch (13 mm); fabricated for drilled-in application to frame.

2.11 DOOR GASKETING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Door Gasketing:
 - a. National Guard Products, Inc.
 - b. Reese Manufacturing Co., Inc.
 - 2. Door Bottoms:
 - a. National Guard Products
 - b. Reese Manufacturing Co., Inc.
- B. Standard: Comply with BHMA A156.22.
- C. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.
 - 1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
 - 3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- D. Air Leakage: Not to exceed **0.50 cfm per foot** (**0.000774 cu. m/s per m**) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
- E. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.
- F. Fire-Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL 10B or NFPA 252.
- G. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.
- H. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- I. Gasketing Materials: Comply with ASTM D 2000 and AAMA 701/702.

2.12 THRESHOLDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. National Guard Products, Inc.
 - 2. Reese Manufacturing Co., Inc.
- B. Standard: Comply with BHMA A156.21.

2.13 FABRICATION

- A. Manufacturer's Nameplate: Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved by Architect.
 - 1. Manufacturer's identification will be permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Steel Machine or Wood Screws: For the following fire-rated applications:

- a. Mortise hinges to doors.
 - b. Strike plates to frames.
 - c. Closers to doors and frames.
- 3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:
 - a. Surface hinges to doors.
 - b. Closers to doors and frames.
 - c. Surface-mounted exit devices.
- 4. Spacers or Sex Bolts: For through bolting of hollow metal doors.
- 5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.14 FINISHES

- A. Standard: Comply with BHMA A156.18.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. BHMA Designations: Comply with base material and finish requirements indicated by the following:
 - 1. BHMA 600: Primed for painting, over steel base metal.
 - 2. BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.
 - 3. BHMA 628: Satin aluminum, clear anodized, over aluminum base metal.
 - 4. BHMA 630: Satin stainless steel, over stainless steel base metal.
 - 5. BHMA 652: Satin chromium plated over nickel, over steel base metal.
 - 6. BHMA 689: Aluminum painted, over any base metal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107.
- B. Wood Doors: Comply with DHI A115-W series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
 - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Key Control System: Place keys on markers and hooks in key control system cabinet, as determined by final keying schedule. Supply key cabinet with 25% expansion. Factory install keys in cabinet or in field with owner's representative. Key cabinet to be supplied with a "Complete System" equal to the Telkee System.
- D. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings, in equipment room. Verify location with Architect.
 - 1. Configuration: Provide one power supply for each door opening.
 - 2. Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware.

- E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: Owner or Architect will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 - 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
 - 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 - 3. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- B. Six-Month Adjustment: Approximately six months after date of Substantial Completion, Installer shall perform the following:
 - 1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
 - 2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
 - 3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.8 DOOR HARDWARE SCHEDULE

Hardware Set #: 0001 - PRS DRS WD & HMF
A3-F370

Opening to Have:

Qty	Description	Finish	Mfg
6	HINGE FBB168 5 x 4.5 x NRP	652	BEST
1	RIM CYLINDER (IC) 1E72 x RP x ABC x CORMAX	626	BEST
2	POWER TRANSFER PT1000	628	ABH
1	POWER SUPPLY PS914 x 9002RS	600	VON DUPRIN
1	SVR EXIT DEVICE QEL-RX-LD-9927 x 996NL-L-06 x LBR	626	VON DUPRIN
1	SVR EXIT DEVICE QEL-RX-LD-9927 x 996L-DT-06 x LBR	626	VON DUPRIN
2	AUTOMATIC OPERATOR MAGIC FORCE	628	STANLEY
2	WALL ACTUATOR 10PB1	630	BEA
2	KICK PLATE 16" x 1" LDW .050 x B4E x CTSK	630	ABH
2	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
2	WALL STOP AB409	630	ABH
2	SILENCERS 1229A	GRAY	TRIMCO
2	DOOR CONTACT MC-7 x SPDT x 1" DIA		DORMAKABA
1	CARD READER BY SECURITY CONTRACTOR		
1	A-PHONE BY SECURITY CONTRACTOR		

Hardware Set #: 0002 - PRS DRS WD & HMF LABEL (DOUBLE EGRESS)
A3-F380 A3-F380-1

Opening to Have:

Qty	Description	Finish	Mfg
6	HINGE FBB168 5 x 4.5 x NRP	652	BEST
2	SVR EXIT DEVICE 9927EO-F x LBR	626	VON DUPRIN
2	DOOR CLOSER 4040XP x REG	689	LCN
4	KICK PLATE 16" x 1" LDW .050 x B4E x CTSK x ULS	630	ABH
2	ELECTROMAGNETIC HOLDER 2100 x RECESSED	628	ABH
1	TEAR DROP SEAL 5050B x HEAD & JAMBS	BLK	NGP

Hardware Set #: 0003 - SGL DRS WD & HMF
A3-F301 A3-F311 A3-F311-1 A3-F325 A3-F346

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	STOREROOM LOCKSET 93K7-D-15D-S3 x ABC x CORMAX	626	BEST
1	ELECTRIC STRIKE 1006CS x 12/24VDC	630	HES
1	DOOR CLOSER 4040XP x REG	689	LCN
1	KICK PLATE 10" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO
1	DOOR CONTACT MC-7 x SPDT x 1" DIA		

DORMAKABA
1 CARD READER BY SECURITY CONTRACTOR

Hardware Set #: 0004 - SGL DRS WD & HMF
A3-F302

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5 x NRP	652	BEST
1	STOREROOM LOCKSET 93K7-D-15D-S3 x ABC x CORMAX	626	BEST
1	ELECTRIC STRIKE 1006CS x 12/24VDC	630	HES
1	DOOR CLOSER 4040XP x EDA	689	LCN
1	KICK PLATE 10" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO
1	DOOR CONTACT MC-7 x SPDT x 1" DIA		

DORMAKABA
1 CARD READER BY SECURITY CONTRACTOR

Hardware Set #: 0005 - SGL DRS WD & HMF
A3-F303 A3-F304 A3-F305 A3-F306 A3-F326 A3-F347 A3-F348
A3-F349
A3-F361

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	PRIVACY LOCKSET 45H0-L-15H x VIB	630	BEST
1	DOOR CLOSER 4040XP x REG	689	LCN
1	KICK PLATE 10" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO

Hardware Set #: 0006 - SGL DRS WD & HMF LABEL
DOOR HARDWARE

TEMPLE UNIVERSITY HEALTH SYSTEM
ICU RENOVATION
STANTEC PROJECT NO. 177902965

REVISION 00

A3-F310 A3-F312 A3-F312-1 A3-F324 A3-F324-1 A3-F328

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 5 x 4.5	652	BEST
1	STOREROOM LOCKSET 93K7-D-15D-S3 x ABC x CORMAX	626	BEST
1	ELECTRIC STRIKE 1006CS x 12/24VDC	630	HES
1	DOOR CLOSER 4040XP x REG	689	LCN
1	KICK PLATE 16" x 2" LDW .050 x B4E x CTSK x ULS	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK x ULS	630	ABH
1	WALL STOP AB409	630	ABH
1	TEAR DROP SEAL 5050B x HEAD & JAMBS	BLK	NGP
1	DOOR CONTACT MC-7 x SPDT x 1" DIA		DORMAKABA
1	CARD READER BY SECURITY CONTRACTOR		

Hardware Set #: 0007 - SGL DRS WD & HMF LABEL
A3-F310-1

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	STOREROOM LOCKSET 93K7-D-15D-S3 x ABC x CORMAX	626	BEST
1	ELECTRIC STRIKE 1006CS x 12/24VDC	630	HES
1	DOOR CLOSER 4040XP x REG	689	LCN
1	KICK PLATE 16" x 2" LDW .050 x B4E x CTSK x ULS	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK x ULS	630	ABH
1	WALL STOP AB409	630	ABH
1	TEAR DROP SEAL 5050B x HEAD & JAMBS	BLK	NGP
1	DOOR CONTACT MC-7 x SPDT x 1" DIA		DORMAKABA
1	CARD READER BY SECURITY CONTRACTOR		

Hardware Set #: 0008 - SGL DRS WD & HMF
A3-F313 A3-F322

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	STOREROOM LOCKSET 93K7-D-15D-S3 x ABC x CORMAX	626	BEST
1	DOOR CLOSER 4040XP x REG	689	LCN
1	KICK PLATE 16" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO

Hardware Set #: 0009 - PRS DRS WD & HMF LABEL
A3-F315

Opening to Have:

Qty	Description	Finish	Mfg
6	HINGE FBB168 4.5 x 4.5 x NRP	652	BEST
1	AUTOMATIC FLUSH BOLTS 1868 x FIRE BOLT x WD	630	ABH
1	STOREROOM LOCKSET 93K7-D-15D-LESS-STK x ABC x CORMAX	626	BEST
1	ASTRAGAL A548B x BEVEL EDGE x FULL HEIGHT	630	ABH
1	POWER TRANSFER PT1000	628	ABH
1	COORDINATOR 3700 x FILLER BAR	BLK	ABH
2	MOUNTING BRACKET 3751/3752	BLK	ABH
1	ELECTRIC STRIKE 1006CS x 12/24VDC	630	HES
2	DOOR CLOSER 4040XP x SCUSH	689	LCN
2	KICK PLATE 16" x 1" LDW .050 x B4E x CTSK x ULS	630	ABH
2	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK x ULS	630	ABH
1	TEAR DROP SEAL 5050B x HEAD & JAMBS	BLK	NGP
2	DOOR CONTACT MC-7 x SPDT x 1" DIA		DORMAKABA
1	CARD READER BY SECURITY CONTRACTOR		

Hardware Set #: 0010 - SGL DRS WD & HMF
A3-F316

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	CLASSROOM LOCKSET 93K7-R-15D-S3 x ABC x CORMAX	626	BEST
1	KICK PLATE 10" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO

Hardware Set #: 0011 - SGL DRS WD & HMF
A3-F360

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 5 x 4.5	652	BEST
1	STOREROOM LOCKSET 93K7-D-15D-S3 x ABC x CORMAX	626	BEST
1	KICK PLATE 16" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO

Hardware Set #: 0012 - SGL DRS WD & HMF
A365.1 A369.1 A374.1

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	PASSAGE LATCHSET 93K0-N-15D-S3	626	BEST
1	KICK PLATE 10" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO

Hardware Set #: 0013 - PRS DRS WD & HMF LABEL
A3-F327

Opening to Have:

Qty	Description	Finish	Mfg
6	HINGE FBB168 4.5 x 4.5	652	BEST
1	AUTOMATIC FLUSH BOLTS 1868 x FIRE BOLT x WD	630	ABH
1	STOREROOM LOCKSET 93K7-D-15D-LESS-STK x ABC x CORMAX	626	BEST
1	ASTRAGAL A548B x BEVEL EDGE x FULL HEIGHT	630	ABH
1	POWER TRANSFER PT1000	628	ABH
1	COORDINATOR 3700 x FILLER BAR	BLK	ABH
1	ELECTRIC STRIKE 1006CS x 12/24VDC	630	HES
2	DOOR CLOSER 4040XP x REG	689	LCN
2	KICK PLATE 16" x 1" LDW .050 x B4E x CTSK x ULS	630	ABH
2	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK x ULS	630	ABH
1	TEAR DROP SEAL 5050B x HEAD & JAMBS	BLK	NGP
2	DOOR CONTACT MC-7 x SPDT x 1" DIA		DORMAKABA
1	CARD READER BY SECURITY CONTRACTOR		

Hardware Set #: 0014 - SGL DRS WD & HMF
A3-F340 A3-F341 A3-F342 A3-F343

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	OFFICE LOCKSET 93K7-AB-15D-S3 x ABC x CORMAX	626	BEST
1	KICK PLATE 10" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO

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Hardware Set #: 0015 - SGL DRS WD & HMF
A3-F345

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5 x NRP	652	BEST
1	PRIVACY LOCKSET 45H0-L-15H x VIB	630	BEST
1	DOOR CLOSER 4040XP x EDA	689	LCN
1	KICK PLATE 10" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO

Hardware Set #: 0016 - SGL DRS WD & HMF
A3-F363

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5 x NRP	652	BEST
1	RIM CYLINDER (IC) 1E72 x RP x ABC x CORMAX	626	BEST
1	RIM EXIT DEVICE LD-99NL-L x 996NL-L-06	626	VON
DUPRIN			
1	DOOR CLOSER 4040XP x EDA	689	LCN
1	KICK PLATE 16" x 2" LDW .050 x B4E x CTSK	630	ABH
1	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
3	SILENCERS 1229A	GRAY	TRIMCO

Hardware Set #: 0017 - PRS DRS WD & HMF
A3-F363A

Opening to Have:

Qty	Description	Finish	Mfg
6	HINGE FBB168 5 x 4.5 x NRP	652	BEST
1	FLUSH BOLT 1855S 1" x 6-3/4" x 12" x TOP ONLY	626	ABH
1	STOREROOM LOCKSET 93K7-D-15D-S3-7/8 x ABC x CORMAX	626	BEST
1	DUMMY TRIM 93K0-1DT-15D	626	BEST
1	ASTRAGAL A548B x BEVEL EDGE x FULL HEIGHT	630	ABH
2	MOP PLATE 6" x 1" LDW .050 x B4E x CTSK	630	ABH
1	WALL STOP AB409	630	ABH
2	SILENCERS 1229A	GRAY	TRIMCO
1	DOOR TO SWING 180 DEGREES		

Hardware Set #: 0018 - SGL DRS ALUM DRS & ALUM FR (WIDE STILE)
A3-F314 A3-F323 A3-F330 A3-F362

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	CLASSROOM LOCKSET 93K7-R-15D x ABC x CORMAX	626	BEST
1	EXTENDED STRIKE LIP REQUIRED FOR ALUMINUM FRAME	630	ROCKWOOD
1	WALL STOP AB409	630	ABH

Hardware Set #: 0019 - SGL DRS ALUM DRS & ALUM FR (WIDE STILE)
A3-F320 A3-F321

Opening to Have:

Qty	Description	Finish	Mfg
3	HINGE FBB168 4.5 x 4.5	652	BEST
1	CLASSROOM LOCKSET 93K7-R-15D x ABC x CORMAX	626	BEST
1	EXTENDED STRIKE LIP REQUIRED FOR ALUMINUM FRAME	630	ROCKWOOD
1	O/H CONCEALED HOLDER 454S	630	GLYNN-JOHNSON

END OF SECTION 08 70 00

SECTION 088000

GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing units.
- C. Plastic films.
- D. Glazing compounds.

1.02 RELATED REQUIREMENTS

- A. Section 084243 - Intensive Care Unit / Critical Care Unit Entrances: Glazing provided as part of entrance assembly.
- B. Section 088813 - Fire-Rated Glazing.
- C. Section 088836.16 - Electronically Controlled Switchable Glass for glass systems.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
- C. {RSTEMP#311}ASCE 7 - Minimum Design Loads for Buildings and Other Structures{CH#193833}.
- D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
- F. ASTM C1036 - Standard Specification for Flat Glass.
- G. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- H. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- I. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
- J. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings.
- K. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.
- L. GANA (GM) - GANA Glazing Manual.
- M. GANA (SM) - GANA Sealant Manual.

- N. GANA (LGRM) - Laminated Glazing Reference Manual.
- O. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use.
- P. NFRC 100 - Procedure for Determining Fenestration Product U-factors.
- Q. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
- R. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by each of the affected installers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit two samples 12 by 12 inch in size of glass units.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.
- F. Manufacturer's qualification statement.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM), GANA (SM), GANA (LGRM), and IGMA TM-3000 for glazing installation methods. Maintain one copy on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years documented experience.
- D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- E. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201.
 - 1. Safety Glazing at exterior curtainwall and window wall systems, adjacent to walking surfaces/floor systems where the elevation change is 30 inches or greater, shall comply with IBC 2406.4.3 and ANSI Z97.1 Category A. Interior glazing systems, both glass and framing system, shall comply with IBC 2403.4, and be laminated safety glazing.

2. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of manufacturer acceptable to authorities having jurisdiction.
3. Where glazing units, including Kind FT glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials; for lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.
4. Interior Safety Glazing located adjacent to walking surfaces/floor systems or where the elevation change from one side of the glass to the other is 30 inches or less, shall comply with IBC 2406.4.3 and ANSI Z97.1 Category A. Interior glazing systems, both glass and framing system, shall comply with IBC 2403.4, and be tempered safety glazing.
5. Interior Safety Glazing located adjacent to walking surfaces/floor systems where the elevation change from one side of the glass to the other is 30 inches or greater shall comply with building code requirement for guardrail systems, and be tempered safety glazing .

1.07 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Insulating Glass Units: Provide a twelve (12) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.
- C. Laminated Glass: Provide a ten (10) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Float Glass Manufacturers:
 1. Vitro Architectural Glass (formerly PPG Glass); _____: www.vitroglazings.com/#sle.
 2. Substitutions: See Section 016000 - Product Requirements.
- B. Plastic Films Manufacturers:
 1. See Drawings for manufacturers of plastic films.
 2. Substitutions: See Section 016000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass. Glass thickness designations indicated are minimums and are for detailing

only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Design Pressure: Calculated in accordance with ASCE 7
 2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - a. The thicknesses determined shall be based upon a probability of breakage not to exceed eight lites per 1000 for vertical glazing (less than 15 degrees from vertical) and one lite per 1000 for sloped glazing (15 degrees or more from vertical).
 3. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 4. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.03 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 2. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
 3. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
 4. Tinted Type: ASTM C1036, Class 2 - Tinted, Quality - Q3, with color and performance characteristics as indicated.
 5. Patterned Glass Type: ASTM C1036, Type II - Patterned Flat Glass, Quality - Q5, Form 3 - Patterned glass, with color and performance characteristics as indicated.
 6. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.

2.04 INSULATING GLASS UNITS

- A. Manufacturers:
1. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.
- B. Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.
- C. Insulating Glass Units: Types as indicated.
1. Durability: Certified by an independent testing agency to comply with ASTM E2190.

2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 3. Warm-Edge Spacers: Low-conductivity thermoplastic with dessicant warm-edge technology design.
 - a. Spacer Width: As required for specified insulating glass unit.
 - b. Spacer Height: Manufacturer's standard.
 4. Spacer Color: Black.
 5. Edge Seal:
 - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone sealant as secondary seal applied around perimeter.
 - b. Color: Black.
 6. Purge interpane space with dry air, hermetically sealed.
- D. Insulating Glass Units: Vision glass, double glazed.
1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with argon.
 3. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Blue.
 - b. Coating: Low-E (passive type), on #2 surface.
 - c. Product: Vitro Solarban 70.
 4. Warm-edge spacer.
 5. Inboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 6. Total Thickness: 1 inch.
 7. Thermal Transmittance (U-Value), Winter - Center of Glass: .28, nominal.
 8. Visible Light Transmittance (VLT): 31 percent, nominal.
 9. Solar Heat Gain Coefficient (SHGC): 0.19, nominal.
 10. Visible Light Reflectance, Outside: 7 percent, nominal.
 11. Glazing Method: Dry glazing method, gasket glazing.
- E. Insulating Glass Units: Vision glass, double glazed.
1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with argon.
 3. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 - b. Coating: Ceramic frit, on #1 surface.
 - c. Coating: Low-E (passive type), on #2 surface.
 4. Warm-edge spacer.
 5. Inboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 6. Total Thickness: 1 inch.
- F. Insulating Glass Units: Spandrel glazing.
1. Applications: Exterior spandrel glazing unless otherwise indicated.
 2. Space between lites filled with argon.
 3. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: Blue.
 - b. Coating: Low-E (passive type), on #2 surface.

- c. Product: Vitro Solarban 70XL
- 4. Warm-edge spacer.
- 5. Inboard Lite: Fully tempered float glass, 1/4 inch thick.
 - a. Tint: Clear.
 - b. Opacifier: Ceramic frit, on #4 surface.
 - c. Opacifier Color: As selected by Architect.
- 6. Total Thickness: 1 inch.
- 7. Glazing Method: Dry glazing method, gasket glazing.

2.05 GLAZING UNITS

- A. Monolithic Interior Vision Glazing:
 - 1. Applications: Interior glazing unless otherwise indicated.
 - 2. Glass Type: Fully tempered float glass.
 - 3. Tint: Clear.
 - 4. Thickness: 1/4 inch, nominal.
- B. Monolithic Interior Vision Glazing:
 - 1. Applications: Interior glazing unless otherwise indicated.
 - 2. Glass Type: Fully tempered float glass.
 - 3. Tint: Ultra-Clear.
 - 4. Thickness: 1/4 inch, nominal.

2.06 PLASTIC FILMS

- A. Type F-3 - Decorative Plastic Film: Polyvinyl butyral (PVB) type.
 - 1. Application: Locations as indicated on drawings.
 - 2. Color: As indicated on drawings.

2.07 GLASS COATINGS

- A. Opacifying Coating: One component, water-based silicone elastomeric opaque color coating for roll coat and spray applications.
 - 1. Application: Exterior spandrel location as indicated on drawings.
 - a. Glass and Coating Orientation at Spandrels: On surface facing interior.
 - 2. Fabrication of Glass Unit with Coating: Solely by Approved Factory Fabricators trained and certified annually by coating manufacturer.
 - 3. Color: Selected from manufacturer's standard range and indicated on drawings.
 - 4. Products:
 - a. ICD High Performance Coatings; OPACI-COAT-300: www.icdcoatings.com/#sle.

2.08 GLAZING COMPOUNDS

- A. Type GC-2 - Butyl Sealant: Single component; ASTM C920 Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.
- B. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.
- C. Manufacturers:

1. Tremco Commercial Sealants & Waterproofing; Proglaze SSG:
www.tremcosealants.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

2.09 ACCESSORIES

- A. Setting Blocks: Silicone, with 85 +/-5 Shore A durometer hardness; ASTM C864 Option II, chemically compatible with glazing sealant or compound. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.
- B. Spacer Shims: Silicone, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 4 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.
- C. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

2.10 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- C. Verify that sealing between joints of glass framing members has been completed effectively.
- D. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.
- E. Installation constitutes acceptance of conditions.

3.02 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.

- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, etc.

3.04 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners. Use edge blocks where indicated or needed to prevent glass lites from walking laterally within opening
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 INSTALLATION - DRY GLAZING METHOD (TAPE AND GASKET SPLINE GLAZING)

- A. Application - Exterior Glazed: Set glazing infills from the exterior of the building.
- B. Cut glazing tape to length; install on glazing pane. Seal corners by butting tape and sealing junctions with butyl sealant.
- C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- D. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
- E. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
- F. Carefully trim protruding tape with knife.

3.06 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
- C. Monitor and report installation procedures and unacceptable conditions.

3.07 CLEANING

- A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

- B. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- C. Remove nonpermanent labels immediately after glazing installation is complete.
- D. Clean glass and adjacent surfaces after sealants are fully cured.
- E. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.08 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

SECTION 088813
FIRE-RATED GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire-rated glazing units.
- B. Glazing compounds.

1.02 RELATED REQUIREMENTS

- A. Section 081113 - Hollow Metal Doors and Frames: Glazed lites in doors and borrowed lites.
- B. Section 081416 - Flush Wood Doors: Glazed lites in doors.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
- C. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
- D. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- E. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass.
- F. ASTM C1193 - Standard Guide for Use of Joint Sealants.
- G. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings.
- H. GANA (GM) - GANA Glazing Manual.
- I. GANA (SM) - GANA Sealant Manual.
- J. GANA (LGRM) - Laminated Glazing Reference Manual.
- K. ICC (IBC) - International Building Code.
- L. IGMATM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use.
- M. ITS (DIR) - Directory of Listed Products.
- N. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
- O. NFPA 257 - Standard on Fire Test for Window and Glass Block Assemblies.
- P. UL (DIR) - Online Certifications Directory.
- Q. UL 9 - Standard for Fire Tests of Window Assemblies.

- R. UL 10B - Standard for Fire Tests of Door Assemblies.
- S. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene preinstallation meeting one week before starting work of this section; require attendance by each of affected installers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data on Glazing Unit Glazing Types: Provide structural, physical, and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Certificate: Certify that products of this section meet or exceed specified requirements.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Specimen warranty.

1.06 QUALITY ASSURANCE

- A. Perform work in accordance with GANA (GM), GANA (SM), GANA (LGRM), and IGMA TM-3000 for glazing installation methods. Maintain one copy on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.
 - 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
- C. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.
- D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.

1.07 FIELD CONDITIONS

- A. Ambient Conditions: Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during, and 24 hours after installation of glazing compounds.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.

- B. Manufacturer Warranty for Laminated Glass: Provide 5-year manufacturer warranty coverage for delamination, including providing products to replace failed units, and commencing on the Date of Substantial Completion. Complete forms in Owner's name and register with manufacturer.
- C. Manufacturer Warranty for Heat Soaked Tempered Glass: Provide 5-year manufacturer warranty coverage for spontaneous breakage of fully tempered glass caused by nickel sulfide (NiS) inclusions, and commencing on the Date of Substantial Completion. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire-Protection-Rated Glass:
 - 1. Manufacturers:
 - a. McGrory Glass, Inc: www.mcgrory.com/fire-rated-glass/#sle.
 - b. SCHOTT North America Inc: www.us.schott.com/#sle.
 - c. Technical Glass Products: www.fireglass.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads and withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 2. Provide glass edge support system sufficiently stiff to limit lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 3. Glass thicknesses listed are minimum.

2.03 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Kind FT - Fully Tempered Type: Comply with ASTM C1048.
 - 2. Thicknesses: As indicated.
- B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
 - 1. Laminated Safety Glass: Comply with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.
 - 2. Polyvinyl Butyral (PVB) Interlayer: 0.030 inch thick, minimum.

2.04 GLAZING UNITS

- A. Fire-Protection-Rated Glazing: Type, thickness, and configuration of glazing that contains flame, smoke, and does not block radiant heat, as required to achieve indicated fire rating period of 90 minutes or less.
 - 1. Applications:
 - a. Glazing in fire-resistance-rated door assembly.
 - b. Glazing in fire-resistance-rated window assembly.
 - c. Other locations as indicated on drawings.

2. Glass Type: Safety ceramic glass.
3. Provide products listed by ITS (DIR) or UL (DIR) and approved by authorities having jurisdiction.
4. Safety Glazing Certification: 16 CFR 1201 Category II.
5. Glazing Method: As required for fire rating.
6. Fire-Rating Period: As indicated on drawings.
7. Markings for Fire-Protection-Rated Glazing Assemblies: Provide permanent markings on fire-protection-rated glazing in compliance with ICC (IBC), local building code, and authorities having jurisdiction
 - a. "D" - meets fire door assembly criteria of NFPA 252, UL 10B, or UL 10C fire test standards.
 - b. "OH" - meets fire window assembly criteria, including hose stream test of NFPA 257 or UL 9 fire test standards.
 - c. "H" - meets fire door assembly hose stream test of NFPA 252, UL 10B, or UL 10C fire tests standards.
 - d. "XXX" - placeholder that represents fire-rating period, in minutes.

2.05 ACCESSORIES

- A. Setting Blocks: Aluminum silicate, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Continuous by one half the height of glazing stop by thickness to suit application, self adhesive on one face.
- C. Glazing Gaskets: Flexible intumescent seals.
- D. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

2.06 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Provide shop inspection and testing for glass.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- C. Verify that sealing between joints of glass framing members has been completed effectively.
- D. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION - GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers unless more stringent requirements are indicated, including those in referenced glazing standards.
- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- F. Prevent glass from contact with contaminating substances that may result from construction operations including, but not limited to weld spatter, fire-safing, plastering, mortar droppings, etc.

3.04 INSTALLATION - DRY GLAZING METHOD (TAPE AND TAPE)

- A. Application - Interior Glazed: Set glazing infills from interior of building.
- B. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch above sightline.
- C. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
- D. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
- E. Place glazing tape on free perimeter of glazing in same manner described above.
- F. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- G. Carefully trim protruding tape with knife.

3.05 FIELD QUALITY CONTROL

- A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.

3.06 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.

- C. Remove nonpermanent labels immediately after glazing installation is complete.
- D. Clean glass and adjacent surfaces after sealants are fully cured.
- E. Clean glass on both exposed surfaces not more than four days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.07 PROTECTION

- A. After installation, mark pane with 'X' by using removable plastic tape or paste; do not mark heat-absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

SECTION 088836.16

ELECTRONICALLY CONTROLLED SWITCHABLE GLASS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electronically controlled (EC) switchable privacy laminated glass units (LGU) and associated system controls.

1.02 RELATED REQUIREMENTS

- A. Section 084243 - Intensive Care Unit / Critical Care Unit Entrances : Supporting framework for EC LGU.
- B. Section 260526 - Grounding and Bonding for Electrical Systems: Control system grounding and bonding.
- C. Section 260533.13 - Conduit for Electrical Systems: Control system conduit.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements for control system cabling and other components.

1.03 ABBREVIATIONS AND ACRONYMS

- A. EC - Electronically Controlled.
- B. LGU - Laminated Glass Units.

1.04 DEFINITIONS

- A. Bite: Width that edge of glass product is engaged into glazing channel.
- B. Busbar: Thin narrow strip of metal that conducts electricity, and is used to apply voltage across the EC surface of switchable glass or film.
- C. Fenestration: Openings in building's envelope including windows, doors, and skylights.
- D. Frame Cable: Cable that runs through framing system and connects EC glass pigtail to low voltage wiring system of building.
- E. Framing System: Metal supporting structure of EC glazing system.
- F. Glazing Performance Characteristics and Criteria for EC Laminated Glass Units (LGU):
 - 1. Privacy Mode: Natural (Off) state, with lowest visible light transmission.
 - 2. Non-Privacy Mode: Active (On) state, with highest visible light transmission.
- G. Laminated Glass: Two sheets of monolithic glass bonded together with interlayer sheet by heat and pressure.
- H. Pigtail: Electrical leads that extends from individual EC LGU.

1.05 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
- C. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
- D. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- E. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass.
- F. ASTM C1184 - Standard Specification for Structural Silicone Sealants.
- G. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings.
- H. GANA (GIB 01-0300) - Glass Informational Bulletin (Proper Procedures for Cleaning Architectural Glass Products).
- I. GANA (GIB TD-02-0402) - Glass Informational Bulletin (Heat-Treated Glass Surfaces are Different).
- J. GANA (GM) - GANA Glazing Manual.
- K. IGMATM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use.
- L. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- M. NFPA 70 - National Electrical Code.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate installation of EC switchable glass as required for project configuration with following related building elements:
 - 1. Cables in framing system of exterior fenestration.
 - 2. Cables in wall and ceiling systems.
 - 3. Control system components.
 - 4. Electrical power supply.
- B. Preinstallation Meeting: Conduct preinstallation meeting one week prior to start of this Work to review procedures, schedules, safety, and coordination with other elements of project; attendance required by the following:
 - 1. Owner's Representative.
 - 2. EC switchable glass manufacturer's representative.
 - 3. Manufacturer's representatives for systems that require an interface with this Work.
 - 4. Other installers affected by this Work.

1.07 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's product data sheets including installation instructions.
- C. Shop Drawings: Submit the following for EC switchable glass overall system in accordance with project configuration indicated.

1. Support Framing System: Include framing system and accommodations for cables, components, cable routing, location of connectors, and exits from framing system.
2. Control System: Indicate location of system components, proposed routing of system cabling, and associated power requirements.
 - a. Include schematic wiring diagram showing field connections.
 - b. Include requirements for interface with other systems.
- D. Integration with Other Systems: Include information on two examples of prior installations that have been operating for at least one year and demonstrate successful integration between proposed systems.
- E. Samples: Two EC switchable glass samples, with each achieving two end states, and no intermediate states.
- F. Designer's qualification statement.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.
- I. Operation and maintenance data.
- J. Specimen warranty.
- K. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements for additional provisions.

1.08 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
- C. Installer Qualifications: Company specializing in performing work specified in this section, with at least five years of documented experience and approved by manufacturer.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's instruction for receiving, handling, storing, and protecting materials.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- C. Store materials in original packaging, protected from exposure to harmful environmental conditions including static electricity, and at temperature and humidity conditions recommended by manufacturer.
- D. After removal from EC switchable glass manufacturer's packaging, remove any labels on glazing within 30 days after exposure to sunlight or other ultra-violet light sources.
- E. Exercise care to prevent edge damage to glass, wiring, and coatings on glass.

1.10 FIELD CONDITIONS

- A. Ambient Conditions: Ensure that substrate surface and ambient air temperature are at least 40 degrees F and rising, and remain above that temperature for at least 24 hours after application of sealants.
- B. Maintain ambient temperature at greater than 32 degrees F during installation of system related cabling.
- C. Provide an activated climate-controlled interior environment for installation of EC switchable glass control system components.

1.11 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide five-year manufacturer warranty for EC switchable glass units with laminated glass products against lamination defects, including edge separation or delamination that materially obstruct vision through the glass. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. EC Switchable Privacy Laminated Glass Units (LGU):
 - 1. Manufacturers:
 - a. Basis of Design manufacturer is Innovative Glass Corporation.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS

- A. EC Privacy LGU System:
 - 1. Control Requirements:
 - a. Provide system capable of privacy with electric current applied and nonprivacy in "off" state in each glazing pane.
 - b. Configure zones for independent control of specific areas of glazing as indicated on drawings.
 - c. Interface with Other Systems:
 - 1) Provide products compatible with other system(s) requiring interface.
 - 2. Framing and Other Glazing Systems: Comply with following requirements for framing used for EC privacy LGU, and other adjacent non-EC glazing that are not considered part of this Work.
 - a. Refer to Section 084243 - Intensive Care Unit and Critical Care Unit Entrances for additional framing system requirements.
 - b. Framing and glazing system compatibility shall be approved by EC switchable LGU manufacturer.
 - c. Comply with following for framing and LGU:
 - 1) Edge Clearance: 1/8 inch.
 - 2) Bite Clearance: 5/8 inch.
 - 3) Face Clearance: 1/8 inch.
 - 4) Contains controls wiring for EC switchable LGU as necessary.

- 5) Provide glazing materials compatible with EC switchable LGU.
- d. Deterioration of Laminated Glass: Withstands development of defects that include edge separation or delamination that obstructs vision through glass.
- e. Provide holes in framing system to run pigtailed and frame cables, sized per manufacturer's requirements, with grommets to protect cables from damage.
- 3. Sizes and shapes of EC switchable LGU to comply with glazing manufacturer's guideline requirements and limitations as indicated.
- 4. Provide type and thickness of interior glazing assemblies to support assembly dead loads, and to withstand live loads acting normal to plane of glass.
 - a. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - b. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - c. Glass thicknesses listed are minimum.

2.03 CONTROLS

- A. Unless specifically indicated to be excluded, provide required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, and system programming, etc. as necessary for a complete EC switchable glass and film operating system.
- B. Provide control system and associated components that achieve system control requirements described under PERFORMANCE REQUIREMENTS article above.
- C. Manual Control Switches:
 - 1. Allows selection of full tint, full clear, and any intermediate tint states.
 - 2. Provides indication of current tint level.
 - 3. One switch capable of controlling multiple zones.
 - 4. One or more switches capable of controlling same zone.
- D. Class 2 Low Voltage Cables: Plenum rated.
- E. Use weathertight connectors for connection of frame cables to IGU pigtailed.

2.04 GLASS MATERIALS

- A. Float Glass: Glazing to be float glass unless otherwise indicated.
 - 1. Kind HS - Heat Strengthened and Kind FT - Fully Tempered in accordance with ASTM C1048.
 - 2. Thicknesses: As indicated.
- B. Laminated Glass: Float glass laminated in accordance with ASTM C1172 and fabricated in autoclave with heat and pressure, free of foreign substances and air pockets.
 - 1. Safety Glass: Comply with ANSI Z97.1 and 16 CFR 1201 test requirements for Category II.
 - 2. Interlayer, Heavy Duty: Ionoplast type, clear, 0.035 inch thick, minimum.

2.05 ELECTRONICALLY CONTROLLED (EC) PRIVACY LAMINATED GLASS UNITS (LGU)

- A. EC Privacy LGU: Maximum size of 48 inch by 110 inch and minimum size of 12 inch by 12 inch.

1. EC laminated glass with switchable film between two glass lites and attached to power source.
2. Applications: As indicated on drawings.
3. Laminated Lite:
 - a. Outer Ply, Glass Type: Kind FT - Fully Tempered float glass.
 - 1) Nominal Thickness: Manufacturers standard thickness for performance requirements indicated.
 - 2) Glass Color: Class 1 - Clear.
 - 3) Transparent optical coating applied to Surface No. 2.
 - b. Inner Ply, Glass Type: Kind FT - Fully Tempered float glass.
 - 1) Nominal Thickness: Manufacturers standard for performance requirements indicated.
 - 2) Glass Color: Class 1 - Clear.
 - c. Interlayer: Heavy duty ionoplast type.
4. Overall Thickness of LGU: As necessary for performance requirements indicated.

2.06 CONNECTORS

- A. EC Glass Busbars: Provide along edge of glass, and elsewhere as necessary, in accordance with EC tintable IGU performance requirements indicated.
 1. Pigtails: Multiconductor sheathed cable extending from edge of EC tintable IGU and terminated with weatherproof connector for connection to frame cable within glazing pocket.
 - a. Pigtail Length: 6 inch, minimum.
 - b. Provide 7/16 inch minimum diameter hole through framing.
- B. EC Film Busbars: Manufacturer's standard, preinstalled along top edge of film.
 1. Pigtails: Low-voltage wiring presoldered to busbars and attached securely to glass panel.

2.07 ACCESSORIES

- A. Glazing Materials: Compatible with EC switchable glass components.
- B. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II.
 1. Size: Length of 0.1 inch for each square foot of glazing or at least 4 inch long by width of glazing pocket space less 1/16 inch wide by height to suit glazing method, glass pane weight and area.
- C. Edge Spacer Shims/Blocks: Silicone, with 50 to 60 Shore A durometer hardness; ASTM C864 Option II.
 1. Size: At least 3 inch long by one half the depth of the glazing stop by thickness to suit application, self adhesive on one face.
- D. Structural Silicone Sealant: Self-priming, elastomeric adhesive complying with ASTM C1184 and recommended by EC film manufacturer.
- E. Glass Cleaner: As recommended by EC film manufacturer.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- A. Verify that site conditions are acceptable for installation of EC switchable glass system components.
- B. Verify openings for installation of EC switchable glass are correctly sized and within acceptable tolerances.
- C. Verify that framing weep system is operating properly and in accordance with GANA (GM) recommendations.
- D. Verify that required minimum face and edge clearances are being maintained.
- E. Verify that glazing channels, weeps and recesses are clear and free of obstructions and ready for glazing.
- F. Verify that glazing pocket is dry where EC switchable glass pigtail and frame cable connection are required to be made.
- G. Verify that framing system is sized appropriately for EC switchable glass thickness and proper precautions are taken to not over compress edge seals upon installation.
- H. Verify that EC switchable glass secondary seal is compatible with glazing sealants.
- I. Verify frame channel dimensions are adequate for required cable runs to be made.
- J. Verify locations of penetrations within framing system are acceptable for frame cables and sensor cables into building.
- K. Verify electrical rough-in of any conduits and/or boxes required for installation of cables and system devices is complete.

3.02 PREPARATION

- A. Prepare glazing channels and other framing members to receive EC switchable glass, pigtails, and frame cable in accordance with manufacturer's recommendations and project requirements.
- B. Remove coatings and other harmful materials from glazing substrates that may inhibit specified EC switchable glass performance requirements.
- C. Ensure that system related cabling is conditioned at room temperature for at least 24 hours prior to installation.

3.03 ELECTRONICALLY CONTROLLED SWITCHABLE GLASS UNITS INSTALLATION

- A. Install system components in accordance with manufacturer's recommendations for LGU, IGU, sealants, gaskets and other glazing materials, pigtails, and frame cables and in compliance with more stringent requirements as indicated in GANA (GM).
- B. Comply with framing manufacturer's and referenced industry recommendations regarding installation of expansion joints and anchors, accommodation of thermal movement, glass openings, use of setting blocks and spacer shims, and weep system layout.
- C. Install EC switchable glass in prepared glazing channels and framing members in compliance with glass manufacturer's labels and indicated glass orientations.

- D. Install glazing units so that active switchable areas of glazing unit extend from edge to edge of finished window system opening without any visible light transmitted along entire perimeter of each glazing unit.
- E. Protect glass from edge damage during handling and installation.
- F. Protect EC switchable glass pigtail, frame and sensor cables from any damage during installation.
 - 1. Use grommets during installation to protect pigtails and cables routed through framing.
 - 2. When frame cable or connector is damaged during installation, replace in accordance with EC switchable glass manufacturer's approved method.
 - 3. When EC switchable glass pigtail connector is damaged during installation, notify EC switchable glass manufacturer for repair or replacement of damaged components using manufacturer's approved method.
- G. Install cabling so that it will not be exposed to direct sunlight, even through glass.
 - 1. Where installation in an exposed location is necessary, cover or paint cable using a latex water based paint in accordance with manufacturer's approved method.
- H. Install setting blocks in glazing pocket as recommended by applicable glazing standards in accordance with GANA (GM) or IGMA TM-3000, and EC switchable glass manufacturer's glazing guidelines.
- I. Install edge spacer shims at each side glazing pocket to prevent IGU's from moving horizontally upon installation.
- J. Provide bite on glass, minimum edge and face clearances, and glazing material tolerances as indicated in GANA (GM) and as approved by manufacturer.
- K. Provide fully functional weep system throughout IGU framing system as indicated in GANA (GM).
- L. Distribute weight of IGU along entire bottom edge rather than only at corners.
- M. Install IGU's in accordance with IGMA TM-3000, and as follows:
 - 1. For dry glazed systems, provide an adequate seal consisting of at least 4 lbs per inch and not exceeding 10 lbs per inch pressure applied to the edges of IGU's by gaskets or other acceptable glazing materials.

3.04 CONTROL SYSTEM INSTALLATION

- A. Perform control system installation work in accordance with NECA 1 and in compliance with NFPA 70 requirements.
- B. Install system components in accordance with manufacturer's requirements.
- C. Mounting Locations:
 - 1. Manual Control Switches: At height indicated on drawings.
- D. Class 2 Low Voltage Wiring Method: Unless noted otherwise, use cables not installed in conduit where possible.
 - 1. Install Class 2 low voltage wiring in conduit where required for rough-in, where required by authorities having jurisdiction, and where exposed to damage.
 - 2. Conduit: Comply with Section 260533.13.
 - 3. Conceal cables unless specifically indicated to be exposed.

- 4. Route exposed cables parallel or perpendicular to building structural members and surfaces.
- E. Provide grounding and bonding in accordance with Section 260526.
- F. Install firestopping to maintain fire resistance rating as indicated for partitions and other elements, using materials and methods specified in Section 078400.
- G. Identify system wiring and components in accordance with Section 260553.

3.05 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Verify that EC switchable glass and corresponding pigtail cables are installed in proper orientation in accordance with approved shop drawings.
- C. Test to verify wiring is free of shorts and grounds.
- D. Prepare and start system in accordance with manufacturer's instructions.
- E. Program system in accordance with project requirements.
- F. Test system to confirm for proper operation.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- H. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.06 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean EC switchable glass on both exposed glass surfaces immediately after installation and curing of sealants in accordance with manufacturer's, GANA (GIB 01-0300) and GANA (GIB TD-02-0402) requirements.
 - 1. Remove labels and markings from glass.
 - 2. Do not use scrapers or other metal tools to clean glass.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals for closeout submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.
- C. Demonstration: Demonstrate operation of EC switchable glass control system and equipment to Owner's designated personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.
- D. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

3.08 PROTECTION

- A. Protect EC switchable glass installations from subsequent construction operations until Date of Substantial Completion.
- B. Protect glass from coming into contact with contaminating construction related substances such as weld spatter, fireproofing, plaster, and concrete or mortar slurry.
- C. Remove damaged glass that is broken, chipped, cracked, or damaged in any way, and replace with new materials.
 - 1. Damaged Glass: Glass with edge damage or other imperfections that when installed could weaken glass and impair performance and/or appearance.

SECTION 090561

COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
 - 1. Resilient tile and sheet.
 - 2. Thin-set ceramic tile and stone tile.
- B. Removal of existing floor coverings.
- C. Preparation of existing concrete floor slabs for installation of floor coverings.
- D. Testing of concrete floor slabs for moisture and alkalinity (pH).
- E. Testing of existing concrete floor slabs for moisture and alkalinity (pH) has already been conducted; test report is attached.
- F. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
 - 1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.
- G. Patching compound.
- H. Remedial floor coatings.

1.02 RELATED REQUIREMENTS

- A. Section 017419 - Construction Waste Management and Disposal: Handling of existing floor coverings removed.

1.03 REFERENCE STANDARDS

- A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens).
- B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete.
- C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- D. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- E. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.05 SUBMITTALS

- A. Visual Observation Report: For existing floor coverings to be removed.
- B. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
 - 1. Moisture and alkalinity (pH) limits and test methods.
 - 2. Manufacturer's required bond/compatibility test procedure.
- C. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.
 - 1. Manufacturer's statement of compatibility with types of flooring applied over remedial product.
 - 2. Test reports indicating compliance with specified performance requirements, performed by nationally recognized independent testing agency.
 - 3. Manufacturer's installation instructions.
- D. Testing Agency's Report:
 - 1. Description of areas tested; include floor plans and photographs if helpful.
 - 2. Summary of conditions encountered.
 - 3. Moisture and alkalinity (pH) test reports.
 - 4. Copies of specified test methods.
 - 5. Recommendations for remediation of unsatisfactory surfaces.
 - 6. Product data for recommended remedial coating.
 - 7. Submit report to Architect.
 - 8. Submit report not more than two business days after conclusion of testing.
- E. Adhesive Bond and Compatibility Test Report.
- F. Floor Moisture Testing Technician Certificate: International Concrete Repair Institute (ICRI) Concrete Slab Moisture Testing Technician- Grade I certificate.

1.06 QUALITY ASSURANCE

- A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.
- B. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
 - 1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.
- C. Contractor's Responsibility Relating to Independent Agency Testing:
 - 1. Provide access for and cooperate with testing agency.
 - 2. Confirm date of start of testing at least 10 days prior to actual start.
 - 3. Allow at least 4 business days on site for testing agency activities.
 - 4. Achieve and maintain specified ambient conditions.

5. Notify Architect when specified ambient conditions have been achieved and when testing will start.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, handle, and protect products in accordance with manufacturer's instructions and recommendations.
- B. Deliver materials in manufacturer's packaging; include installation instructions.
- C. Keep materials from freezing.

1.08 FIELD CONDITIONS

- A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.
- B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
 1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
 2. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.
- B. Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.
- C. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
 1. Thickness: As required for application and in accordance with manufacturer's installation instructions.
 2. Use product recommended by testing agency.

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

- A. Follow recommendations of testing agency.

B. Perform following operations in the order indicated:

1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
 - a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
 - b. Removal of existing floor covering.
2. Existing concrete slabs with coatings or penetrating sealers/hardeners/dustproofers:
 - a. Do not attempt to remove coating or penetrating material.
 - b. Do not abrade surface.
3. Preliminary cleaning.
4. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
5. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
6. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
7. Specified remediation, if required.
8. Patching, smoothing, and leveling, as required.
9. Other preparation specified.
10. Adhesive bond and compatibility test.
11. Protection.

C. Remediations:

1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating or remedial sheet membrane over entire suspect floor area.
3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.02 REMOVAL OF EXISTING FLOOR COVERINGS

- A. Comply with local, State, and federal regulations and recommendations of RFCI Recommended Work Practices for Removal of Resilient Floor Coverings, as applicable to floor covering being removed.
- B. Dispose of removed materials in accordance with local, State, and federal regulations and as specified.

3.03 PRELIMINARY CLEANING

- A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.
- B. Do not use solvents or other chemicals for cleaning.

3.04 MOISTURE VAPOR EMISSION TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.
- C. Test in accordance with ASTM F1869 and as follows.
- D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.
- F. Report: Report the information required by the test method.

3.05 INTERNAL RELATIVE HUMIDITY TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.
- C. Test in accordance with ASTM F2170 Procedure A and as follows.
- D. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.
- F. Report: Report the information required by the test method.

3.06 ALKALINITY TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. The following procedure is the equivalent of that described in ASTM F710, repeated here for the Contractor's convenience.
 - 1. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.
 - 2. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (pH) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (pH) reading.
 - 3. Use of a digital pH meter with probe is acceptable; follow meter manufacturer's instructions.
- C. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.07 PREPARATION

- A. See individual floor covering section(s) for additional requirements.
- B. Comply with recommendations of testing agency.
- C. Comply with requirements and recommendations of floor covering manufacturer.
- D. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.
- E. Do not fill expansion joints, isolation joints, or other moving joints.

3.08 ADHESIVE BOND AND COMPATIBILITY TESTING

- A. Comply with requirements and recommendations of floor covering manufacturer.

3.09 APPLICATION OF REMEDIAL FLOOR COATING

- A. Comply with requirements and recommendations of coating manufacturer.

3.10 PROTECTION

- A. Cover prepared floors with building paper or other durable covering.

SECTION 092116
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Resilient sound isolation clips.
- D. Acoustic insulation.
- E. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 054000 - Cold-Formed Metal Framing: Structural steel stud framing and she.
- B. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 078400 - Firestopping: Top-of-wall assemblies at fire-resistance-rated walls.
- D. Section 079200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members.
- B. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data.
- C. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing.
- D. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing.
- E. {RSTEMP#451}ASTM A36/A36M - Standard Specification for Carbon Structural Steel;2014.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- G. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
- H. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.
- I. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- J. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

- K. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- L. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
- M. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
- N. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- O. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
- P. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.
- Q. ASTM C1396/C1396M - Standard Specification for Gypsum Board.
- R. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- S. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- T. ASTM E413 - Classification for Rating Sound Insulation.
- U. GA-216 - Application and Finishing of Gypsum Panel Products.
- V. GA-226 - Application of Gypsum Board to Form Curved Surfaces.
- W. GA-600 - Fire Resistance and Sound Control Design Manual.
- X. ICC (IBC) - International Building Code.
- Y. UL (FRD) - Fire Resistance Directory.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- C. Sequencing: Install service utilities in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on gypsum board, accessories, and joint finishing system.
 - 1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.
 - 2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- C. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.
- D. Steel Framing Industry Association (SFIA) Certification:

1. Submit documentation that metal studs and connectors used on project meet or exceed requirements of International Building Code.
 2. Submit current documentation of contractor and fabricator accreditation. Keep copies of each on-site during and after installation, and present upon request.
- E. Test Reports: For stud framing products that do not comply with AISI S220 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- F. SSFSA Manufacturer Qualification: Submit documentation of manufacturer association membership.
- G. SSMA Manufacturer Qualification: Submit documentation of manufacturer association membership.
- H. Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

- A. Delegated Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B. Installer Qualifications: Company specializing in performing gypsum board installation and finishing, with minimum 5 years of experience.
- C. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.
- D. Manufacturer Qualifications: Member of Supreme Steel Framing System Association (SSFSA): www.ssfsa.com/#sle.
- E. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years of documented experience.
- F. Documents at Project Site: Maintain at the project site a copy of manufacturer's instructions, erection drawings, and shop drawings.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- B. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Interior Partitions, Indicated as Acoustic: Provide completed assemblies with the following characteristics:
1. Acoustic Attenuation: STC as indicated calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:

1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
 2. Acoustic Attenuation: STC as indicated on Drawings, calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- D. Grid Suspension Systems: Provide grid suspension systems in accordance with ASTM C840 and GA-216.
- E. Fire-Resistance-Rated Assemblies: Provide completed assemblies as indicated on the drawings and as complying with applicable code.
1. ICC IBC Item Numbers: Comply with applicable requirements of ICC IBC for the particular assembly.
 2. Gypsum Association File Numbers: Comply with requirements of GA-600 for the particular assembly.
 3. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.02 METAL FRAMING MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
1. Structural Grade: As required to meet design criteria.
 - a. Equivalent gage studs not permitted at installations of areas to receive wall tile.
 2. Corrosion Protection Coating Designation: G40, or equivalent in accordance with AISI S220.
- C. Structural Steel Framing for Application of Gypsum Board: See Section 054000.
- D. Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
1. Studs: C-shaped with flat faces.
 2. Runners: U shaped, sized to match studs.
 3. Ceiling Channels: C-shaped.
 4. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
- E. Shaft Wall Studs and Accessories: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
- F. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.
 3. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
 4. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-resistance rating of the wall assembly.
- G. Preformed Top Track Firestop Seal:

1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
- H. Preformed Top of Wall Firestop Gasket:
 1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
- I. Non-structural Framing Accessories:
 1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
 - a. Materials: {RS#451} formed sheet steel support member with factory-welded ASTM A1003/A1003M steel plate base.
 3. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.
- J. Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 1. American Gypsum Company: www.americangypsum.com/#sle.
 2. CertainTeed Corporation: www.certainteed.com/#sle.
 3. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 4. National Gypsum Company: www.nationalgypsum.com/#sle.
 5. USG Corporation: www.usg.com/#sle.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold resistant board is required at locations shown on Drawings, including but not limited to plumbing fixture walls.
 3. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 4. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 5/8 inch.
 - c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.
- C. Unfaced fiber-reinforced gypsum panels, suitable for paint finish:
 1. Application: At unit shower wall and ceiling enclosures.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Unfaced Type: Interior fiber-reinforced gypsum panels, as defined in ASTM C1278/C1278M.
 4. Unfaced Products:
 - a. USG Corporation, Fiberock Brand Aqua-Tough™ Abuse Resistant Panels
 5. Thickness: 5/8 inch.
 6. Edges: Tapered.

- D. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
 - 1. Application: Vertical surfaces behind thinset tile, except in wet areas.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Type: Regular and Type X, in locations indicated.
 - 4. Type X Thickness: 5/8 inch.
 - 5. Regular Board Thickness: 5/8 inch.
 - 6. Edges: Tapered.
- E. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
 - 1. Paper-Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Paper-Faced Products:
 - a. American Gypsum Company; M-Bloc Shaft Liner: www.americangypsum.com/#sle.
 - b. CertainTeed Corporation; M2Tech Type X Shaftliner: www.certainteed.com/#sle.
 - c. Georgia-Pacific Gypsum; ToughRock Shaftliner: www.gpgypsum.com/#sle.
 - d. National Gypsum Company; Gold Bond Fire-Shield Shaftliner XP: www.nationalgypsum.com/#sle.

2.04 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: As indicated in partition schedules.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
 - 1. Products:
 - a. Franklin International, Inc; Titebond GREENchoice Professional Acoustical Smoke and Sound Sealant: www.titebond.com/#sle.
 - b. Liquid Nails, a brand of PPG Architectural Coatings: www.liquidnails.com/#sle.
 - c. Specified Technologies Inc; Smoke N Sound Acoustical Sealant: www.stifirestop.com/#sle.
- C. Partition Gap Closure shall meet specified performance requirements listed in ASTM E1399/E1399M-97 for the joint width minimum and maximum dimension verification as well as the cyclic movement performance for Class IV – Combined movement which encompasses Seismic, Thermal and Wind Sway, movement at a cycling rate greater than or equal to 10 cycles per minute.
 - 1. Basis of Design: MullionMate by Gordon Architectural Engineering Solutions, or approved substitute.
 - 2. Configurations: See drawings for required closure accessory configurations required.
- D. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 - 1. Types: As detailed or required for finished appearance.
 - 2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
 - 3. Products:
 - a. Same manufacturer as framing materials.

- E. Beads, Joint Accessories, and Other Trim: ASTM C1047, galvanized steel, unless noted otherwise.
 - 1. Corner Beads: Low profile, for 90 degree outside corners.
 - 2. Architectural Reveal Beads:
 - a. Reveal Depth: As shown on drawings.
 - b. Reveal Width: As shown on drawings.
 - c. Shapes: As indicated on drawings.
 - 3. Expansion Joints:
 - a. Type: V-shaped metal with factory-installed protective tape.
- F. Decorative Metal Trim:
 - 1. Material: Extruded aluminum alloy 6063-T5 temper.
 - 2. Finish: Anodized, clear.
 - 3. Type: Profile as selected from manufacturer's standard range.
- G. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Fiberglass Tape: 2 inch wide, coated glass fiber tape for joints and corners.
 - 2. Paper Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 - 3. At wet walls and walls receiving tile, provide gypsum manufacturers' recommended tape.
 - 4. Joint Compound: Drying type, vinyl-based, ready-mixed.
 - 5. Joint Compound: Setting type, field-mixed.
- H. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- I. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
 - 1. Install studs at spacing required to meet performance requirements.
- B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.
 - 1. On walls over sixteen feet high, screw-attach studs to runners top and bottom.
 - 2. Seal perimeter of shaft wall and penetrations with acoustical sealant.

3.03 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.

- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
- C. Studs: Space studs as scheduled.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Acoustic Furring: Install resilient channels at maximum 24 inches on center. Locate joints over framing members.
- F. Blocking: Install mechanically fastened steel sheet blocking for support of:
 - 1. Framed openings.
 - 2. Wall-mounted cabinets.
 - 3. Plumbing fixtures.
 - 4. Toilet partitions.
 - 5. Toilet accessories.
 - 6. Wall-mounted door hardware.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.05 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Nonrated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
 - 1. Exception: Tapered edges to receive joint treatment at right angles to framing.
- C. Double-Layer, Nonrated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- D. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- E. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
- F. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.
- D. Decorative Trim: Install at locations shown on drawings and in accordance with manufacturer's instructions.

3.07 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 3. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.

3.08 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.09 PROTECTION

- A. Protect installed gypsum board assemblies from subsequent construction operations.

SECTION 093000

TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Non-ceramic trim.

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants: Sealing joints between tile work and adjacent construction and fixtures.

1.03 REFERENCE STANDARDS

- A. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar.
- B. ANSI A108.1b - Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set, Modified Dry-Set, or Improved Modified Dry-Set Cement Mortar.
- C. ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set, Modified Dry-Set, or Improved Modified Dry-Set Cement Mortar.
- D. ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship.
- E. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive.
- F. ANSI A108.5 - Setting of Ceramic Tile with Dry-Set Cement Mortar, Modified Dry-Set Cement Mortar, EGP (Exterior Glue Plywood) Modified Dry-Set Cement Mortar, or Improved Modified Dry-Set Cement Mortar.
- G. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy.
- H. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout.
- I. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout.
- J. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework.
- K. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units.

- L. ANSI A108.12 - Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Modified Dry-Set Mortar.
- M. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone.
- N. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar.
- O. ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs.
- P. ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation.
- Q. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation.
- R. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation.
- S. ANSI A118.15 - American National Standard Specifications for Improved Modified Dry-Set Cement Mortar.
- T. ANSI A137.1 - American National Standard Specifications for Ceramic Tile.
- U. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products.
- V. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, and setting details.
- D. Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches in size illustrating pattern, color variations, and grout joint size variations.
- E. Master Grade Certificate: Submit for each type of tile, signed by the tile manufacturer and tile installer.
- F. Installer's Qualification Statement:
- G. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 10 square feet of each size, color, and surface finish combination.

1.05 QUALITY ASSURANCE

- A. Maintain one copy of and ANSI A108/A118/A136 and TCNA (HB) on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.
- C. Installer Qualifications:
 - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.07 FIELD CONDITIONS

- A. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 TILE

- A. Manufacturers: All products by the same manufacturer.
 - 1. Dal-Tile Corporation; _____: www.daltile.com/#sle.
- B. Ceramic Mosaic Tile: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 0.5 to 3.0 percent as tested in accordance with ASTM C373.
 - 2. Size: 2 by 4 inch, nominal.
 - 3. Shape: Rectangle.
 - 4. Edges: Square.
 - 5. Surface Finish: Matte glazed.
 - 6. Color(s): As indicated on drawings.
 - 7. Pattern: Brick joint mosaic.
 - 8. Trim Units: Matching surface bullnose base in sizes indicated.
 - 9. Products:
 - a. See drawings for requirements.
- C. CeramicWall Tile: ANSI A137.1 standard grade.
 - 1. Moisture Absorption: 0.5 to 3.0 percent as tested in accordance with ASTM C373.
 - 2. Size: 12 by 24 inch, nominal.
 - 3. Shape: Rectangle.
 - 4. Edges: Square.
 - 5. Surface Finish: Matte glazed.
 - 6. Color(s): As indicated on drawings.
 - 7. Pattern: As indicated on drawings..
 - 8. Products:
 - a. See drawings for requirements.

2.02 TRIM AND ACCESSORIES

- A. Trim: Satin natural anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Applications:
 - a. Open edges of wall tile.
 - 2. Manufacturers:
 - a. Schluter-Systems: www.schluter.com/#sle.

2.03 SETTING MATERIALS

- A. Provide setting and grout materials from same manufacturer.
- B. Improved Latex-Portland Cement Mortar Bond Coat: ANSI A118.15.
 - 1. Applications: Use this type of bond coat where Large and Heavy Tile (LHT) mortar is indicated.

2.04 GROUTS

- A. Provide setting and grout materials from same manufacturer.
- B. High Performance Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
 - 1. Applications: Use this type of grout where indicated and where no other type of grout is indicated.
 - 2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
 - 3. Color(s): As indicated on drawings.

2.05 MAINTENANCE MATERIALS

- A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
 - 1. Applications: Between tile and plumbing fixtures.
 - 2. Color(s): As selected by Architect from manufacturer's full line.
- B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
 - 1. Composition: Water-based colorless silicone.

2.06 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 - 1. Crack Resistance: No failure at 1/8 inch gap, minimum.
 - 2. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: 20 mils, maximum.
- B. Waterproofing Membrane: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
 - 1. Fluid or Trowel Applied Type:
 - a. Material: Acrylic.

- b. Thickness: 25 mils, minimum, dry film thickness.
- c. Products:
 - 1) USG Corporation; Durock Brand Liquid Waterproofing Membrane:
www.usg.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- B. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for tiling installation by testing for moisture and alkalinity (pH).
 - 1. Test in accordance with Section 090561.
 - 2. Obtain instructions if test results are not within limits recommended by tiling material manufacturer and setting material manufacturer.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners neatly. Align wall joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles square.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- J. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.

- K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.
 - 1. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F122, with latex-Portland cement grout.

3.05 INSTALLATION - WALL TILE

- A. On exterior walls install in accordance with TCNA (HB) Method W244, thin-set over cementitious backer units, with waterproofing membrane.
- B. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.
- C. Over gypsum wallboard on wood or metal studs install in accordance with TCNA (HB) Method W243, thin-set with dry-set or latex-Portland cement bond coat, unless otherwise indicated.

3.06 CLEANING

- A. Clean tile and grout surfaces.

3.07 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

SECTION 095100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
- D. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.
- E. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate grid layout and related dimensioning and mechanical and electrical items installed in the ceiling.
- C. Product Data: Provide data on suspension system components and acoustical units.
- D. Samples: Submit two samples 6 by 6 inch in size illustrating material and finish of acoustical units.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.05 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.
- B. Suspension Systems:
 - 1. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.

2.02 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panels ACT-1: Mineral fiber with membrane-faced overlay, with the following characteristics:
 - 1. Classification: ASTM E1264 Type IV.
 - a. Form: 2, water felted.
 - b. Pattern: "E" - lightly textured.
 - 2. Size: 24 by 24 inches.
 - 3. Thickness: 3/4 inch.
 - 4. Light Reflectance: .88 percent, determined in accordance with ASTM E1264.
 - 5. NRC: 0.75, determined in accordance with ASTM E1264.
 - 6. Ceiling Attenuation Class (CAC): 35, determined in accordance with ASTM E1264.
 - 7. Panel Edge: Beveled tegular.
 - 8. Suspension System: Exposed grid.
 - 9. Products:
 - a. See Drawings for product selections.

2.03 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings and hold down clips as required.
 - 1. Materials:
 - a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
- B. Exposed Suspension System: Hot-dipped galvanized steel grid and cap.
 - 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 - 2. Profile: Tee; 15/16 inch face width.
 - 3. Finish: Baked enamel.
 - 4. Color: White.
 - 5. Products:
 - a. See Drawings for products required..

2.04 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
- C. Hold-Down Clips: Manufacturer's standard clips to suit application
- D. Perimeter Moldings: Same metal and finish as grid.
 - 1. Size: As required for installation conditions.
 - 2. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
- E. Metal Edge Trim: Steel or extruded aluminum; provide attachment clips, splice plates, and preformed corner pieces for complete trim system.
 - 1. Trim Height: See drawings for sizes and configuration.
 - 2. Finish: Baked enamel.
 - 3. Color: White.
- F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.

3.03 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
- E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- I. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:
 - 1. Cut to fit irregular grid and perimeter edge trim.
 - 2. Make field cut edges of same profile as factory edges.
 - 3. Double cut and field paint exposed reveal edges.
- F. Where round obstructions or penetrations occur, provide preformed closures to match perimeter molding.

3.05 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

SECTION 096500
RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient sheet flooring.
- B. Resilient tile flooring.
- C. Static control resilient tile flooring.
- D. Resilient base.
- E. Installation accessories.

1.02 RELATED REQUIREMENTS

- A. Section 090561 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.
- B. Section 090561 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.
- C. Section 260526 - Grounding and Bonding for Electrical Systems: Grounding and bonding of static control flooring to building grounding system.

1.03 REFERENCE STANDARDS

- A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
- B. ASTM F970 - Standard Test Method for Measuring Recovery Properties of Floor Coverings after Static Loading.
- C. ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing.
- D. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile.
- E. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.

1.04 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- B. Shop Drawings: Indicate floor patterns.
- C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
- D. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.

- E. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.
- F. Manufacturer's Qualification Statement.
- G. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Flooring Material: 5 percent of each type and color.
 - 3. Extra Wall Base: 5 percent of each type and color.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum five years documented experience.
- B. Installer Qualifications: Company specializing in installing specified flooring with minimum five years documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing concrete slab moisture testing and inspections of the type specified in this section.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.
- C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
- D. Protect roll materials from damage by storing on end.
- E. Do not double stack pallets.

1.07 FIELD CONDITIONS

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 SHEET FLOORING

- A. Vinyl Sheet Flooring: Aluminum trioxide and colored quartz aggregate throughout thickness of PVC. Colored PVC and clear PVC used to create a dimensional appearance.
 - 1. Manufacturers:
 - a. Altro.
 - 2. Minimum Requirements: Comply with ASTM F1303, Type I, Grade , with Class A fibrous backing.
 - 3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.

4. Wear Layer Thickness: 0.020 inch minimum.
 5. Total Thickness: 0.080 inch minimum.
 6. Sheet Width: 79 inch minimum.
 7. Static Load Resistance: 2000 psi minimum, when tested as specified in ASTM F970.
 8. Seams: Heat welded.
 9. Integral coved base with cap strip.
 10. Color: As indicated on drawings.
- B. Welding Rod: Solid bead in material compatible with flooring, produced by flooring manufacturer for heat welding seams, and in color matching field color.

2.02 TILE FLOORING

- A. Vinyl Tile: Printed film type, with transparent or translucent wear layer.
1. Minimum Requirements: Comply with ASTM F1700, of Class corresponding to type specified.
 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 3. Tile Size: See Drawings for size requirements.
 4. Wear Layer Thickness: 0.020 inch.
 5. Total Thickness: Varies, see Drawings for thickness requirements..
 6. Color: As indicated on drawings.
- B. Static Control Tile: Homogeneous; color and pattern throughout thickness.
1. Minimum Requirements: Solid vinyl tile complying with ASTM F1700, Class 1, Type A.
 2. Electrical Resistance:
 - a. Dissipative Tile: Resistance between 1.0 megohms and 1000 megohms as tested in accordance with ASTM F150.
 3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 4. Tile Size: As indicated on drawings.
 5. Color: As indicated on drawings.

2.03 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; style as scheduled.
1. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 2. Height: 4 inch.
 3. Thickness: 0.125 inch.
 4. Length: Roll.
 5. Color: As indicated on drawings.

2.04 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Moldings, Transition and Edge Strips: Same material as flooring.
- C. Copper Grounding Strips: Type and size as recommended by static control flooring manufacturer.

- D. Floor Polish for Static Control Flooring: Fluid-applied polish, intended to protect electrical properties of flooring, as recommended by static control flooring manufacturer.
- E. Filler for Coved Base: Plastic.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 - 1. Test in accordance with Section 090561.
 - 2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
 - 3. Follow moisture and alkalinity remediation procedures in Section 090561.
- D. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- C. Prohibit traffic until filler is fully cured.
- D. Clean substrate.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Adhesive-Applied Installation:
 - 1. Spread only enough adhesive to permit installation of materials before initial set.
 - 2. Place copper grounding strip in conductive adhesive and apply additional adhesive to top side of strip before installing static control flooring. Allow strip to extend beyond flooring in accordance with static control flooring manufacturer's instructions. Refer to Section 260526 for grounding and bonding to building grounding system.
 - 3. Fit joints and butt seams tightly.
 - 4. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

- E. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 - 1. Resilient Strips: Attach to substrate using adhesive.
- F. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- G. Install flooring in recessed floor access covers, maintaining floor pattern.

3.04 INSTALLATION - SHEET FLOORING

- A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
- B. Cut sheet at seams in accordance with manufacturer's instructions.
- C. Seal seams by heat welding where indicated.
- D. Coved Base: Install as detailed on drawings, using coved base filler as backing at floor to wall junction. Extend sheet flooring vertically to height indicated, and cover top edge with metal cap strip.

3.05 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
- B. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.
- C. Install square tile to indicated pattern. Allow minimum 1/2 full size tile width at room or area perimeter.
- D. Install plank tile with a random offset of at least 6 inches from adjacent rows.

3.06 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.07 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.08 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

SECTION 099000
PAINTING AND COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Interior painting and coating systems.
- C. Exterior painting and coating systems.
- D. Scope:
 - 1. Finish surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - a. Exterior:
 - 1) Metal, Miscellaneous: Metal stairs and steel, ferrous metal.
 - b. Interior:
 - 1) Metal: Structural steel columns, beams, miscellaneous and ornamental structural iron, and ferrous metal.
 - 2) Drywall: Walls, ceilings, gypsum board, and similar items.

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.
- B. SSPC-SP 1 - Solvent Cleaning.
- C. SSPC-SP 3 - Power Tool Cleaning.
- D. SSPC-SP 6 - Commercial Blast Cleaning.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Product characteristics.
 - 2. Surface preparation instructions and recommendations.
 - 3. Primer requirements and finish specification.
 - 4. Storage and handling requirements and recommendations.
 - 5. Application methods.
 - 6. Clean-up information.
- C. Samples: Submit four paper draw down samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
- D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.

- E. Applicator's qualification statement.
- F. Maintenance Data: Submit coating maintenance manual including finish schedule showing where each product/color/finish was used, product technical data sheets, safety data sheets (SDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements for additional provisions.
 - 2. Extra Paint and Finish Materials: 5% of each color; from the same product run, store where directed.
 - 3. Label each container with color in addition to manufacturer's label.

1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 3 years experience and approved by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, product name, product code, color designation, VOC content, batch date, environmental handling, surface preparation, application, and use instructions.
- C. Paint Materials: Store at a minimum of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- D. Handling: Maintain a clean, dry storage area to prevent contamination or damage to materials.

1.06 FIELD CONDITIONS

- A. Do not apply materials when environmental conditions are outside the ranges required by manufacturer.
- B. Follow manufacturer's recommended procedures for producing the best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design Products: Subject to compliance with requirements, and unless otherwise noted, provide Sherwin-Williams Company (The) products indicated; www.sherwin-williams.com/#sle.
- B. Comparable Products: Products of approved manufacturers will be considered in accordance with 016000 - Product Requirements, and the following:
 - 1. Products are approved by manufacturer in writing for application specified.
 - 2. Products that meet or exceed performance and physical characteristics of basis of design products.

2.02 PAINTINGS AND COATINGS

- A. General:
 - 1. Provide factory-mixed coatings unless otherwise indicated.
 - 2. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application.
 - 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless specifically indicated in manufacturer's instructions.
- B. Volatile Organic Compound (VOC) Content:
 - 1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Architectural coatings VOC limits of State in which the project is located.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site, or other method acceptable to authorities having jurisdiction.
- C. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Metal, Miscellaneous: Metal stairs, galvanized and ferrous metal.
 - 1. Alkyd Systems, Water Based:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series: www.sherwin-williams.com/#sle.

2.04 PAINT SYSTEMS - INTERIOR

- A. Metal: Miscellaneous and ornamental iron, structural iron, and ferrous metal.
 - 1. Alkyd Systems, Water Based:
 - a. Low Sheen Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
 - (a) 5 mils wet, 2 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Alkyd Urethane Enamel Low Sheen, B53-1250 Series: www.sherwin-williams.com/#sle.
 - (a) 4 to 5 mils wet, 1.4 to 1.7 mils dry per coat.
- B. Drywall: Walls, ceilings, gypsum board, and similar items.
 - 1. Latex Systems:
 - a. Eg-Shel Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - (a) 4 mils wet, 1.5 mils dry per coat.

- 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Eg-Shel, B20-2600 Series: www.sherwin-williams.com/#sle.
(a) 4 mils wet, 1.7 mils dry per coat.
- b. Flat Finish: Ceilings
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
(a) 4 mils wet, 1.5 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Latex Flat, B30-2600 Series: www.sherwin-williams.com/#sle.
(a) 4 mils wet, 1.6 mils dry per coat.
2. Epoxy Systems, Water Based:
 - a. Eg-Shel/Low Luster Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
(a) 4 mils wet, 1.5 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45 Series: www.sherwin-williams.com/#sle.
(a) 4 mils wet, 1.5 mils dry per coat.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.
- C. Test shop-applied primer for compatibility with subsequent cover materials.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove mildew from impervious surfaces by scrubbing with solution of water and bleach. Rinse with clean water and allow surface to dry.
- D. Galvanized Surfaces:
 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 2. Prepare surface according to SSPC-SP 3.
- E. Ferrous Metal:
 1. Solvent clean according to SSPC-SP 1.
 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Prime bare steel surfaces.
 3. Remove rust, loose mill scale, and other foreign substances using methods recommended by paint manufacturer and blast cleaning according to SSPC-SP 6. Protect from corrosion until coated.

3.03 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions.
- C. Apply coatings at spread rate required to achieve manufacturer's recommended dry film thickness.
- D. Regardless of number of coats specified, apply additional coats until complete hide is achieved.

3.04 PRIMING

- A. Apply primer to all surfaces unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.
- B. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to top coat manufacturers.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

SECTION 101100
VISUAL DISPLAY UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tackboards.

1.02 REFERENCE STANDARDS

- A. ASTM C208 - Standard Specification for Cellulosic Fiber Insulating Board.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics.

PART 2 PRODUCTS

2.01 VISUAL DISPLAY UNITS

- A. Tackboards: Fabric laminated to fiberboard.
 - 1. Fabric: See Finish Legend on drawings for selections.
 - 2. Backing: Fiberboard, 1/2 inch thick, laminated to tack surface.
 - 3. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
 - 4. Size: As indicated on drawings.

2.02 MATERIALS

- A. Fabric: See Finish Legend on drawings.
- B. Fiber Board: ASTM C208, cellulosic fiber board.

2.03 ACCESSORIES

- A. Temporary Protective Cover: Sheet polyethylene, 8 mil thick.
- B. Mounting Brackets: Concealed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.02 PREPARATION

- A. Acclimatize tackable wall panels by removing from packaging in installation area not less than 24 hours before application.
- B. Remove switchplates, wall plates, and surface-mounted fixtures where tackable wall paneling is applied. Reinstall items on completion of installation.
- C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install boards in accordance with manufacturer's instructions.
- B. Secure units level and plumb.
- C. Install tackable wall panels in accordance with manufacturer's recommendations on specified substrates with concealed attachments.

3.04 CLEANING

- A. Clean board surfaces in accordance with manufacturer's instructions.
- B. Cover with protective cover, taped to frame.
- C. Remove temporary protective cover at Date of Substantial Completion.

SECTION 102513
PATIENT BED SERVICE WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Patient bed service walls (PBSW).

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants: Sealing joints between service walls and adjacent wall construction.
- B. Section 092116 - Gypsum Board Assemblies: Reinforcements in metal-framed partitions for anchoring PBSW assemblies or units.
- C. Section 226139 - Medical Gas Piping for Healthcare Facilities: Piping.
- D. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Cables and wiring.
- E. Section 260526 - Grounding and Bonding for Electrical Systems: Personnel safety requirements and provisions for low impedance path to ground for possible ground currents.
- F. Section 262726 - Wiring Devices.
- G. Section 265100 - Interior Lighting: General lighting fixture requirements when installed in, or connected to, the PBSW units.
- H. Section 275223 - Nurse Call System: Requirements for installation in PBSW units.

1.03 ABBREVIATIONS AND ACRONYMS

- A. PBSW: Patient bed service wall.

1.04 DEFINITIONS

- A. Patient Bed Service Wall: Configurable medical gas and electric service assembly or unit employing multiple service rows or columns to conveniently locate medical gas, electrical, and communication devices.
 - 1. Where indicated on drawings as "Headwall", meaning is same as patient bed service wall.

1.05 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.
- B. ANSI A208.1 - American National Standard for Particleboard.
- C. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- D. NEMA LD 3 - High-Pressure Decorative Laminates.

- E. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- F. NFPA 99 - Health Care Facilities Code.
- G. UL (DIR) - Online Certifications Directory.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate installation of units with wall framing, including stud spacing, and size, location, and installation of service utilities.
- B. Preinstallation Meeting: Conduct preinstallation meeting one week prior to start of work of this section; require attendance by all affected installers.
- C. Sequencing: Ensure that facility services connections are achieved in an orderly and expeditious manner.

1.07 SUBMITTALS

- A. Product Data: Provide descriptive literature that includes dimensions, construction, capacities, utility and service requirements, clearances, locations, required accessories, optional features, test reports, certifications.
- B. Shop Drawings: Indicate locations in facility using large-scale plans, elevations, and cross sections.
 - 1. Include all integral utility feeds for coordination with facility utility connections. Coordinate with work under other contracts for scope of work delineation.
 - 2. Include electrical ratings, overall and detailed dimensions, mounting details, rough-in and anchor placement dimensions and tolerances, installation and servicing clearances required, wiring diagrams, materials, and connection diagrams.
 - 3. Include project specific configuration drawings showing arrangement of devices, including nurse call, medical gases, electrical receptacles, and switches.
- C. Certificate: Certify that products of this section meet or exceed specified requirements.
 - 1. Certify that equipment has been properly installed, adjusted, and tested in accordance with manufacturer's recommendations.
- D. Manufacturer's qualification statement.
- E. Installer's qualification statement.
- F. Operation and Maintenance Manuals: Include wiring diagrams, technical data sheets, and information for ordering replacement parts.
 - 1. Identify terminals on wiring diagrams to facilitate installation, maintenance and operation.
 - 2. Maintenance Data: Identify system maintenance requirements, servicing cycles, lubrication types required, and local spare part sources.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- H. Project Record Documents: Record actual locations of concealed facility services connections.

1.08 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.

- B. Installer's Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
- C. Preconstruction Testing: Factory-test components of service walls.
 - 1. Factory-test medical gas manifolds in compliance with NFPA 99.

1.09 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Provide one mock-up of each type of PBSW specified, indicating installation interface with walls and coordination with patient bed placement.
- C. Locate where directed.
- D. Mock-up may remain as part of work.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Package each system component to ensure protection from damage during shipment and delivery. Legibly indicate on exterior of each container or crate, shipping address and brief description of contents. Outside of container, fasten waterproof envelope containing packing list and complete instructions for uncrating and handling contents.
- B. Coordinate maximum size of each shipment with opening sizes along access routes to places of storage and installation, including sizes of elevator doors and cabs.
- C. Store products clear of floor in manner to prevent damage.
- D. Protect finished surfaces during handling and installation with protective covering of polyethylene film or another suitable material.

1.11 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 10-year manufacturer warranty for service wall system installation. Complete forms in Owner's name and register with manufacturer.
- C. Installer Warranty: Provide 10-year warranty for service wall system installation commencing on the Date of Substantial Completion. Complete forms in Owner's name and register with installer.
- D. Extended Correction Period: Correct defective work within 5-year period commencing on Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Modular Services Company.
- B. Substitutions: See Section 016000 - Product Requirements.

2.02 PATIENT BED SERVICE WALL (PBSW) ASSEMBLIES

- A. UL (DIR) Listings: Provide assemblies, units, and components listed in following categories:
- B. Construction: Assemblies or units consisting of structural framework, removable panels, and removable equipment console units that are factory assembled to house bedside medical services.
 - 1. Include provisions for medical gas fittings, power receptacles and switches, light fixtures, grounding jacks, telephone jacks, data jacks, nurses call patient station, pillow speaker unit and holder, and accessory rails.
 - 2. VOC Limits for Adhesives: Where used in manufacture of PBSW assemblies limit VOC content to 2.1 lb/gal or less when calculated according to 40 CFR 59, Subpart D.
- C. Electrical Receptacles and Switches: See Section 262726.
- D. Lighting: Include following types of luminaires, standard with PBSW manufacturer:
- E. Nurse Call Patient Station: See Section 275223 for nurse call equipment space provisions.

2.03 PBSW CONFIGURATIONS

- A. Single bed PBSW assembly with vertical configuration.
 - 1. Vertical wall-mounted assemblies.
 - a. Vertical assembly width as indicated on drawings.
 - 2. Electrical Services: Wire devices in accordance with schematic diagram indicated on drawings.
 - a. Standby Power Receptacles: NEMA 20R single receptacles, self-illuminated red with stainless steel cover plates, engraved "EMERGENCY POWER" with minimum 1/4 inch red filled letters.
 - b. Normal Power Receptacles: NEMA 20R single white receptacles.
 - 1) Include stainless steel cover plates.
 - c. Nurses Call audio-visual single bed station.
 - 3. Piped Services: See drawings for services required.
 - a. Medical Oxygen Fitting(s).
 - b. Medical Air Fitting(s).
 - c. Vacuum Fittings.

2.04 PATIENT BED SERVICE WALLS FABRICATION

- A. Construct basic structural framework of 14 gauge, 0.067 inch cold-rolled steel sheet.
- B. Construct unit to be self-supporting for above-the-floor, recessed installation.
- C. Drill and tap side frame members to permit installation of front panel devices at modular intervals at any elevation between top and bottom.
- D. Removable Front Panels: Construct panels of one of following materials, as standard with manufacturer for unit types specified:
 - 1. High Pressure Decorative Laminate or HPDL: NEMA LD 3, types as recommended for specific applications, complying with Grade requirements.
 - a. Substrate: Fire-retardant-treated particleboard complying with ANSI A208.1. Composed of wood chips, sawdust, or flakes of medium density, made with waterproof resin binders; of grade to suit application; sanded faces.

2. Secure panels with hidden screws or other means to offer an overall finished appearance.
 3. Exposed metal surfaces or trims greater than 1/8 inch wide to be of anodized aluminum, finished to resist abrasion and effects from harsh cleaning compounds.
- E. Back Panels: Attach side and back panels made of minimum 0.060 inch thick galvanized sheet steel, or equivalent strength aluminum side and back panels, with flush screws to permit close wall mounting. Finish side panels to match or compliment front panels. Match back panel for freestanding units with finish of front and side panels.
- F. Mount patient service components in consoles made up of backbox and finish fascia.
1. Provide galvanized steel backboxes with outlet gang openings on uniform centers to provide mounting supports of front panel devices. Provide removable metal barriers to separate voltage sources and to facilitate wiring between segregated devices within same horizontal module.
 2. Match finish of fascia and device faceplates.
 3. Provide smooth external surfaces having a finished appearance. Maintain adequate spacing of device plates and similar items to eliminate crevices and facilitate cleaning.
 4. Internal Supports: Adequate for conduits and piping within structural frame, and as standard with manufacturer.
 5. Medical Gas Piping: Factory-installed and manifolded for single-point connection at top of unit to facility services.
 - a. Type "L" copper pipe, cleaned, capped, protected from contact with dissimilar metals, and properly identified.
 6. Electrical Wiring: Factory installed.
 - a. Wiring Devices: Complying with NEMA WD 6.
 - b. Electrical components: Factory assembled prewiring may be stranded in sizes 10 AWG and 12 AWG. Provide an equipotential ground bus with lugs suitable for connecting 14 AWG to 6 AWG conductors with minimum 48 screw-type terminals, unless otherwise shown.
 7. Patient Services: Include services indicated in "Configurations" Article, in schematic wiring diagrams on drawings, and as follows:
 - a. Receptacles: Single Hospital Grade NEMA 5-15R or 5-20R, unless otherwise specified. Identify receptacles as required by UL listing.
 - b. Medical Gas Outlets: Compatible with those installed elsewhere in facility, factory assembled, manifolded and prepiped, with medical grade copper pipe, to single point connections of each service at top of units.
 - c. Nurse Call: Provide adequate space and matching faceplates for equipment and empty conduit to sectionalized junction box at top of units.
 - d. Telephone Outlets or Jacks: Plug-in type, coordinated with Owner's system requirements.
 - e. Data Outlets or Jacks: Plug-in type, coordinated with Owner's system requirements.
 - f. Except for anodized aluminum and galvanized or stainless steel surfaces, clean and factory-paint metal surfaces with primer and not less than two coats of baked enamel.

2.05 ACCESSORIES

- A. Manufacturer's standard accessories compatible with service wall, including those shown on Drawings.

2.06 SOURCE QUALITY CONTROL

- A. Single Source Responsibility: Components and materials from single source.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that wall framing, facility services connections, rough-in frames, anchors and supports are accurately placed and deliver services at specified characteristics and within acceptable functional ranges.
- B. Examine areas, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of service walls.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Installation of patient bed service walls noted as OFCI or CFCI is by Contractor. Coordinate with items furnished and or installed by Owner.
- B. Provide services of manufacturer's technical representative to supervise installation, adjustment, testing, and startup.
- C. Install service wall assembly components securely, square, level, and plumb.
- D. Comply with applicable requirements of NFPA 99.
- E. Install and make facility services connections as required for complete and operational PBSW system for each unit or assembly.
 - 1. Coordinate work of affected trades.
 - 2. Electrical Components: Install and test components, wiring, and grounding in accordance with NECA 130.
 - 3. Compressed Air, Oxygen and Vacuum System Components: Install and test components and piping system in accordance with requirements of Section 226000.
- F. Seal along perimeter of service wall system installation using sealant specified in Section 079200.

3.03 TOLERANCES

- A. Maximum Variation From True Position in Any Direction: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

3.04 SYSTEM STARTUP

- A. Provide services of manufacturer's field representative to perform systems startup.
- B. Prepare and start systems in accordance with manufacturers' instructions and recommendations.

3.05 ADJUSTING

- A. Adjust components for proper operation within manufacturer's published tolerances.

- B. Adjust controls and moving parts for smooth operation.

3.06 CLEANING

- A. Clean surfaces as recommended by manufacturer.

3.07 COMMISSIONING

- A. See Section 019113 - General Commissioning Requirements for commissioning requirements.
- B. Test electrical grounding for compliance with requirements of authorities having jurisdiction.
- C. Perform following Functional Tests:
 - 1. Purge and pressure-test piping connecting to service wall piping manifolds in accordance with requirements of NFPA 99.

3.08 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate operation of assemblies and units to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance requirements of each component.
- B. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

3.09 PROTECTION

- A. Protect installed patient bed service walls from subsequent construction operations.

SECTION 102600
WALL AND DOOR PROTECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Bumper rails.
- B. Protective corridor handrails.
- C. Corner guards.
- D. Protective wall covering.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Placement of supports in stud wall construction.
- B. Section 097200 - Wall Coverings: Terminating wall covering at wall and door protection.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- C. Shop Drawings: Include plans, elevation, sections, and attachment details. Show design and spacing of supports for protective corridor handrails, required to withstand structural loads.
- D. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
 - 1. Submit two sections of corner guards, 24 inches long.
 - 2. Submit two samples of protective wall covering, 6 by 6 inches square.
- E. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- G. Maintenance Data: Manufacturer's instructions for care and cleaning of each type of product. Include information about both recommended and potentially detrimental cleaning materials and methods.

1.05 DELIVERY, STORAGE, AND HANDLING

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty for metal crash rails. Complete forms in Owner's name and register with manufacturer.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures or internal connection failures.
 - b. Deterioration of materials beyond that expected of normal use, as intended by manufacturer.
- C. Installer Warranty: Provide 5-year warranty for metal crash rails commencing on Date of Substantial Completion. Complete forms in Owner's name and register with installer.
 - 1. Failures include, but are not limited to, the following:
 - a. Detachment of rail system from substrate.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Protective Corridor Handrails:
 - 1. Inpro; 3500 Series; stainless steel top rail/vinyl bottom: www.inprocorp.com/#sle.
- B. Corner Guards:
 - 1. Inpro: www.inprocorp.com/#sle.
- C. Wall Guards:
 - 1. Inpro; 1500 Series;: www.inprocorp.com/#sle.
- D. Protective Wall Covering:
 - 1. Inpro: www.inprocorp.com/#sle.

2.02 PERFORMANCE CRITERIA

2.03 PRODUCT TYPES

- A. Bumper Rails: Factory- or shop-fabricated, with preformed end caps and internal and external corners:
 - 1. Performance of Installed Assembly:
 - a. Support vertical live load of 100 lb/lineal ft with deflection not to exceed 1/50 of span between supports.
 - b. Resist lateral force of 250 lbs at any point without damage or permanent set.
 - 2. Material: High impact vinyl, color as selected from manufacturer's standard colors.
 - 3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 4. Mounting: Surface.

- B. Protective Corridor Handrails: Factory- or shop-fabricated, with preformed end caps and internal and external corners integral with vinyl bumper system:
 - 1. Material: Metal; Stainless Steel, type 304, No.4 satin finish.
 - 2. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 3. Mounting: Surface.
- C. Corner Guards - Surface Mounted:
 - 1. Material: Polyethylene terephthalate (PET or PETG); PVC-free with full height extruded aluminum retainer.
 - 2. Performance: Resist lateral impact force of 100 lbs at any point without damage or permanent set.
 - 3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 4. Width of Wings: 2 inches.
 - 5. Corner: Square.
 - 6. Color: As selected from manufacturer's standard colors.
 - 7. Length: One piece.
- D. Protective Wall Covering:
 - 1. Material: Polyethylene terephthalate (PET or PETG); PVC and PBTs-free.
 - 2. Thickness: 0.040 inch.
 - 3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - 4. Color: As selected from manufacturer's standard colors.
 - 5. Accessories: Provide manufacturer's standard color-matched trim and moldings.
 - 6. Mounting: Adhesive.
- E. Adhesives and Primers: As recommended by manufacturer.
- F. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.
- G. See Section 092116 for supports in stud wall construction.

2.04 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

2.05 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Provide wall and door protection systems of each type from a single source and manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as indicated on drawings.
- C. Verify that substrate surfaces for adhered items are clean and smooth.
 - 1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.
- D. Start of installation constitutes acceptance of project conditions.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
- B. Position top of bumper rail 36 inches from finished floor.
- C. Position top of corridor hand rail 36 inches from finished floor.
- D. Position corner guard 4 inches above finished floor to ____ inches high.
- E. Terminate rails 1 inch short of door openings and intersecting walls.
- F. Coordinate installation of vinyl fabric wall covering specified in Section 097200 with corner guard retainer and cover.
- G. Position protective wall covering no less than 1 inch above finished floor to allow for floor level variation.
 - 1. Wainscot Installation: Establish a level line at the specified height for entire length of run. Install by aligning top of edge of covering with this line.
 - 2. Apply adhesive with 1/8 inch V-notch trowel to an area of wall surface that can be completed within cure time of the adhesive.
 - 3. Install trim pieces as required for a complete installation. Allow tolerance for thermal movement.
 - 4. At joints indicated to be caulked, allow for a minimum 1/16 inch wide gap between edges of sheets. Gaps are required to be of consistent width throughout the project.
 - 5. Use a roller to ensure maximum contact with adhesive.
 - 6. At inside and outside corners cut covering sheets to facilitate installation of trim pieces or corner guards.

3.03 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch.
- B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

3.04 CLEANING

- A. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

- B. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

SECTION 102800

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Commercial toilet accessories.

1.02 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- B. ASTM C1036 - Standard Specification for Flat Glass.
- C. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror.
- D. ASTM D4802 - Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet.
- E. ASTM D5047 - Standard Specification for Polyethylene Terephthalate Film and Sheeting.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Commercial Toilet, Shower, and Bath Accessories:
 - 1. See Drawings for Schedule of accessories.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
- B. Keys: Provide 3 keys for each accessory to Owner; master key lockable accessories.
- C. Stainless Steel Sheet: ASTM A666, Type 304.
- D. Acrylic Plastic Sheet: ASTM D4802.
- E. PETG Plastic Sheet: ASTM D5047.

- F. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- G. Adhesive: Two component epoxy type, waterproof.
- H. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.

2.04 COMMERCIAL TOILET ACCESSORIES

- A. Grab Bars: Stainless steel, smooth surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force, minimum.
 - b. Dimensions: 1-1/4 inch outside diameter, minimum 0.05 inch wall thickness, exposed flange mounting, 1-1/2 inch clearance between wall and inside of grab bar.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. Verify that field measurements are as indicated on drawings.
- D. See Section 092116 - Gypsum Board Assemblies for installation of blocking and reinforcing plates in walls and ceilings.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
 - 1. Grab Bars: As indicated on drawings.
 - 2. Other Accessories: As indicated on drawings.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

SECTION 104400
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.02 REFERENCE STANDARDS

- A. {RSTEMP#1152}
- B. FM (AG) - FM Approval Guide.
- C. NFPA 10 - Standard for Portable Fire Extinguishers.
- D. UL (DIR) - Online Certifications Directory.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
- D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.04 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Extinguishers:
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. Larsen's Manufacturing Co; Cameo Series: www.larsensmfg.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Size: 10 pound.
 - 3. Finish: Baked polyester powder coat, color as selected.
 - 4. Temperature range: Minus 65 degrees F to 120 degrees F.

2.03 FIRE EXTINGUISHER CABINETS

- A. Fire Rating: Listed and labeled in accordance with {RS#1152} requirements for fire resistance rating of walls where being installed.
- B. Cabinet Construction: Non-fire rated.
 - 1. Formed primed steel sheet; 0.036 inch thick base metal.
- C. Fire Rated Cabinet Construction: Match wall type at installation location.
 - 1. Steel; double wall or outer and inner boxes with 5/8 inch thick fire barrier material.
- D. Cabinet Configuration: Semi-recessed type per installation location shown on drawings.
 - 1. Size to accommodate accessories.
 - 2. Trim: Flat square edge.
- E. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- F. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.
- G. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- H. Finish of Cabinet Exterior Trim and Door: No.4 - Brushed stainless steel.
- I. Finish of Cabinet Interior: White colored enamel.
- J. Product: Basis of Design Model: Larsen's Manufacturing Company: Cameo Series 2409, mounting and fire-rated as indicated by wall types.

2.04 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated.
- B. Lettering: FIRE EXTINGUISHER decal, or vinyl self-adhering, pre-spaced red lettering in accordance with authorities having jurisdiction (AHJ).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install cabinets plumb and level in wall openings, height as indicated from finished floor to inside bottom of cabinet.
- C. Secure rigidly in place.
- D. Place extinguishers in cabinets.

SECTION 105123
PLASTIC-LAMINATE-CLAD LOCKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Plastic-laminate-clad lockers.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design.
- B. ANSI A208.1 - American National Standard for Particleboard.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.
- E. ICC A117.1 - Accessible and Usable Buildings and Facilities.
- F. NEMA LD 3 - High-Pressure Decorative Laminates.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's published data on locker construction, sizes and accessories.
- C. Shop Drawings: Indicate locker plan layout, numbering plan.
- D. Samples: Two 6 by ____ inches in size, of each color scheduled.
- E. Manufacturer's Instructions: Indicate component installation assembly.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Plastic-Laminate-Clad Lockers:
 - 1. Basis of Design: Hollman, Inc: www.hollman.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 LOCKER APPLICATIONS

- A. Plastic-laminate-clad lockers
 - 1. Width: 12 inches.

2. Depth: 18 inches
3. Height: 30 inches.
4. Accessible Units: Lockers constructed to comply with referenced accessibility standards are indicated on drawings.
5. Locker Configuration: Three tier.
6. Fittings: Size and configuration as indicated on drawings.
 - a. Removable ADA shelf.
 - b. Single shoe shelf.
 - c. Hooks: As determined by locker configuration .
7. Ventilation: By open space between back of door and locker body.
8. Locking: Built-in combination locks.
 - a. Basis of Design: Hollman Keyless 1. Finish color as selected.
9. Provide sloped top.
10. Plastic Laminate Color: See drawings for color selections.

2.03 PLASTIC-LAMINATE-CLAD LOCKERS

- A. Accessibility: Design units indicated on drawings as 'accessible' to comply with ICC A117.1 and ADA Standards.
- B. Quality Standard: AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
 1. Plastic-Laminate-Clad Lockers: Custom Grade.
- C. Lockers: Factory assembled, made of plastic-laminate-faced panels: fully finished inside and out; each locker capable of standing alone.
 1. Doors and Panels: Plastic laminate adhesive and pressure bonded to faces and edges of particleboard core, with beveled corners and edges; edges of cut-outs sealed.
 - a. Particleboard for Core: ANSI A208.1 composed of wood chips, sawdust or flakes, made with waterproof resin binder; grade to suit application; sanded faces.
 - b. Plastic Laminate: NEMA LD 3, HGS.
 - c. Adhesive: Contact type.
 2. Doors: Full overlay, covering full width and height of locker body.
 - a. Style: Flat panel.
 3. Locker Body Construction: Manufacturer's standard for selected product.
 4. Where locker ends or sides are exposed, provide same finish as fronts or provide extra panels to match fronts.
 5. Provide filler strips where indicated, securely attached to lockers.
- D. Component Thicknesses:
 1. Doors: 3/4 inch minimum thickness.
 2. Locker Body: Tops, bottoms, sides, and shelves 5/8 inch; backs 5/8 inch; minimum.
 3. End Panels and Filler Panels: 1/2 inch minimum thickness.
 4. Sloped Tops: 1/2 inch minimum thickness.
 5. Toe Kick Plates: 1/2 inch minimum thickness.
- E. Hinges: Full height of locker, manufacturer's standard heavy duty type.
- F. Coat Hooks: Stainless steel; attached with tamperproof screws.
- G. Number Plates: Provide rectangular shaped aluminum plates. Form numbers 3/8 inch high of block font style with ADA designation, in contrasting color.

H. Built-In Combination Locks:

1. Built-In Combination Lock: Multi-dial combination lock.
 - a. Multi-Dial Numerical Combination Lock: Four vertically-mounted numerical dials; user-defined code, minimum 10,000 combinations; with master key code bypass, retrieval, and reset.
 - b. Latch: Deadbolt.

I. Lock Strike: Stainless steel strike plate attached to locker body with throughbolts.

J. Locker Base: Plastic-laminate-clad base, 4 inches high, field assembled.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that prepared bases are in correct position and configuration.
- B. Verify bases and embedded anchors are properly sized.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Place and secure on prepared base.
- C. Install lockers plumb and square.
- D. Secure lockers with anchor devices to suit substrate materials.
 1. Minimum Pullout Force: 100 lb.
- E. Install end panels, filler panels, and sloped tops.
- F. Install fittings if not factory installed.
- G. Replace components that do not operate smoothly.

3.03 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean locker interiors and exterior surfaces.

SECTION 109910

– MEDICAL EQUIPMENT INFORMATION

GENERAL

1.01 SUMMARY

- A. Section references documents developed by OneEQ that includes the documentation for medical equipment. Furnish and install codes are indicated in the referenced documents, including Contractor furnished and installed items.
- B. The OneEQ documents are as follows and are included under separate cover as Medical Equipment Information Appendix A:
 - 1. Temple ICU Renovations Datasheets document, dated 06/24/2025.
 - 2. Temple ICU Room by Room document, dated 06/24/2025
 - 3. Temple ICU Room by Room with Specifications document, dated 06/24/2025

PRODUCTS (NOT USED)

EXECUTION

3.01 INSTALLATION (GENERAL)

- A. Furnish and install according to Codes indicated in ASE book.
- B. Contractor shall furnish and install in-wall/ceiling blocking for all Contractor installed wall/ceiling mounted medical equipment. Coordinate extent of blocking with medical equipment cut sheets.

SECTION 122400
WINDOW SHADES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior manual roller shades.

1.02 REFERENCE STANDARDS

- A. ASTM E2180 - Standard Test Method for Determining the Activity of Incorporated Antimicrobial Agent(s) in Polymeric or Hydrophobic Materials.
- B. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- C. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
- D. WCMA A100.1 - Standard for Safety of Window Covering Products.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week prior to commencing work related to products of this section; require attendance of affected installers.
- B. Sequencing:
 - 1. Do not fabricate shades until field dimensions for each opening have been taken with field conditions in place.
 - 2. Do not install shades until final surface finishes and painting are complete.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
- C. Shop Drawings: Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.
- D. Certificates: Manufacturer's documentation that line voltage components are UL listed or UL recognized.
- E. Source Quality Control Submittals: Provide test reports indicating compliance with specified fabric properties.
- F. Selection Samples: Include fabric samples in full range of available colors and patterns.
- G. Verification Samples: Minimum size 6 inches square, representing actual materials, color and pattern.

- H. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- I. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of shop drawings.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
- B. Handle and store shades in accordance with manufacturer's recommendations.

1.07 FIELD CONDITIONS

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:
 - 1. Shade Hardware: One year.
 - 2. Fabric: One year.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Interior Manually Operated Roller Shades:
 - 1. SWFcontract, a division of Springs Window Fashions, LLC.; Pro Series Manual Solar Shade System: www.swfcontract.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 ROLLER SHADES

- A. General:
 - 1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
 - 2. Provide shade system that operates smoothly when shades are raised or lowered.
- B. Roller Shades:
 - 1. Description - Interior Roller Shades: Double roller, manually operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories.
 - a. Drop Position: Regular roll.
 - b. Roll Direction: Roll down, closed position is at window sill.
 - c. Mounting: Recess mounted in ceiling pocket and as indicated in details on drawings.
 - d. Size: As indicated on drawings.

- e. Fabric: As indicated under Shade Fabric article.
- 2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - a. Material: Stamped steel.
 - b. Double Roller Brackets: Configured for light-filtering and room-darkening shades in one opening.
 - 1) Light-Filtering Fabric: Room-side of opening.
 - 2) Room-Darkening Fabric: Glass-side of opening.
- 3. Roller Tubes: As required for type of shade operation.
 - a. Material: Extruded aluminum, clear anodized finish.
 - b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge.
- 4. Hembars: Designed to maintain bottom of shade straight and flat.
 - a. Style: Full wrap fabric covered bottom bar, flat profile with heat sealed closed ends.
 - b. Room-Darkening Shades: Provide a slot in bottom bar with wool-pile light seal.
- 5. Manual Operation for Interior Shades:
 - a. Clutch Operator: Manufacturer's standard material and design, permanently lubricated.
 - b. Drive Chain: Continuous loop, beaded ball chain with restraining device, 95 lb minimum breaking strength; comply with WCMA A100.1. Provide upper and lower limit stops.
- 6. Accessories:
 - a. Fascia: Extruded aluminum, size as required to conceal shade mounting, attachable to brackets without exposed fasteners; clear anodized finish.
 - b. End Caps: Provide manufacturer's standard end caps to cover exposed ends of brackets.
 - c. Ceiling Pockets: Premanufactured metal shade pocket for recess mounting shade hardware into ceiling. Provide removable closure panel to conceal underside of brackets and roller tubes.

2.03 SHADE FABRIC

- A. Fabric: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
 - 1. Manufacturers:
 - a. SWF; Latitude X100 - 1%.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - 2. Material: Vinyl coated polyester.
 - 3. Performance Requirements:
 - a. Flammability: Pass NFPA 701 large and small tests.
 - b. Fungal Resistance: No growth when tested in accordance with ASTM G21.
 - c. Antimicrobial Resistance: Greater than 95 percent reduction of bacteria when tested in accordance with ASTM E2180.
 - 4. Openness Factor: 1%.
 - 5. Weight: 17.29 ounces per square yard.
 - 6. Roll Width: 118 inches.
 - 7. Color: As selected by Architect from manufacturer's full range of colors.

- B. Fabric: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
 - 1. Manufacturers:
 - a. SWF; Enterprise Blackout.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - 2. Material: 100 percent polyester.
 - 3. Performance Requirements:
 - a. Flammability: Pass NFPA 701 large and small tests.
 - 4. Weight: 12.70 ounces per square yard.
 - 5. Roll Width: 122 inches.
 - 6. Color: As selected by Architect from manufacturer's full range of colors.

2.04 ROLLER SHADE FABRICATION

- A. Field measure finished openings prior to ordering or fabrication.
- B. Dimensional Tolerances: As recommended in writing by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine finished openings for deficiencies that may preclude satisfactory installation.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Start of installation shall be considered acceptance of substrates.

3.02 PREPARATION

- A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
- B. Coordinate with window installation and placement of concealed blocking to support shades.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
- B. Replace shades that exceed specified dimensional tolerances at no extra cost to Owner.
- C. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.04 CLEANING

- A. Clean soiled shades and exposed components as recommended by manufacturer.
- B. Replace shades that cannot be cleaned to "like new" condition.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate operation and maintenance of window shade system to Owner's personnel.

3.06 PROTECTION

- A. Protect installed products from subsequent construction operations.
- B. Touch-up, repair, or replace damaged products before Substantial Completion.

SECTION 123600

COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Countertops for architectural cabinet work.

1.02 RELATED REQUIREMENTS

- A. Section 064100 - Architectural Wood Casework.

1.03 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. AWI (QCP) - Quality Certification Program.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition.
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.
- E. ISFA 2-01 - Classification and Standards for Solid Surfacing Material.
- F. NEMA LD 3 - High-Pressure Decorative Laminates.
- G. PS 1 - Structural Plywood.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- B. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.
- C. Selection Samples: For each finish product specified, color chips representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.
- E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.
- F. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- G. Installer's qualification statement.
- H. Installation Instructions: Manufacturer's installation instructions and recommendations.

- I. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Natural Stone Institute (NSI) Accredited Natural Stone Fabricator; www.naturalstoneinstitute.org/#sle.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.
- C. Quality Certification:
 - 1. Comply with AWI (QCP) woodwork association quality certification service/program in accordance with requirements for work specified in this section: www.awiqcp.org/#sle.
 - 2. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 3. Provide designated labels on shop drawings as required by certification program.
 - 4. Provide designated labels on installed products as required by certification program.
 - 5. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOPS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 - 1. Flat Sheet Thickness: 1/2 inch, minimum.
 - 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) See drawings..
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.

- c. Finish on Exposed Surfaces: As selected by Architect..
- d. Color and Pattern: As indicated on drawings.
- 3. Other Components Thickness: 1/2 inch, minimum.
- 4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; edge profile as indicated on drawings.
- 5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.

2.02 MATERIALS

- A. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
- B. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- C. Joint Sealant: Mildew-resistant silicone sealant, clear.

2.03 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 - 1. Join lengths of tops using best method recommended by manufacturer.
 - 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install vanities in accordance with manufacturer's instructions and approved shop drawings
- B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- C. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

- A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

SECTION 210000 - FIRE PROTECTION GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Fire Protection Systems used on this project shall be in accordance with Owner's and where applicable Tenant's Fire Protection Design Guidelines and Standards. Consult the Owner, the Tenant, the Architect and the Engineer for further information. Acquire the approval of the Owner and the Tenant prior to final product purchase and installation.
- C. Unless required by the Local Authorities Having Jurisdictions and where the building is classified and categorized by the Structural Engineer as Seismic Design Category – B, All Systems shall be designed with seismic bracing. Where systems cross Building Expansion Joints, piping shall cross with appropriate expansion connections and shall be supported with appropriate bracing as described in related sections of the specifications.
- D. These specifications include information, descriptions and products that may not be specific to this project. It is intended to serve as a general Information related to the discipline.

1.2 SCOPE OF WORK

- A. The scope of the work included under Division 21 of the specifications shall include complete systems as shown in the Contract Documents and specified herein. Any work reasonably inferable or required to result in a complete installation or the intended operation and performance of the systems, shall be included in the Base Bid except where there is specific reference to exclusion and incorporation in other quotations.
- B. Fire Protection Contractor shall examine all construction documents during the bidding phase to ensure fire protection installation can be provided without major modifications to any portion of the building as indicated on the construction documents.

1.3 INTENT OF DRAWINGS

- A. Provide complete and functional systems for the project. The systems shall conform to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform to accepted trade practices. The drawings and specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this contractors work.

- B. Do not scale the drawings. Because of the scale of the drawings, it is not possible to indicate offsets, fittings, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Coordinate and provide fire protection systems in a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items, components, and appurtenances required to meet the project conditions.
- C. These documents may not explicitly disclose final details required for a complete systems installation however, contractors shall have the expertise to coordinate, evaluate, and provide necessary appurtenances for complete operating fire protection systems.
- D. Fire Protection Contractor shall be "Experienced" in this type of construction and realize the extent of the work required.
- E. Where a product model number is indicated on the drawings or specifications and that product model is obsolete or no longer available, the bid price shall include currently available product model from specified manufacture with the same quality, capacity and warranty as the obsolete model listed.

1.4 DISCREPANCIES IN DOCUMENTS

- A. If drawings or specifications conflict or are unclear, the Fire Protection Contractor shall advise Architect / Engineer in writing before award of contract. Otherwise, Architects / Engineers interpretation of contract documents shall be final, and no additional compensation shall be permitted due to discrepancies or clarifications.
- B. Where drawings or specifications do not coincide with manufacturers' recommendations or with applicable codes and standards, the Fire Protection Contractor shall advise Architect / Engineer in writing before award of contract. Otherwise, contractor shall be responsible to provide revisions to their work as directed by architect / engineer within contract price.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specifications, the Fire Protection Contractor shall provide material, installation, or work which is of the higher standard.
- D. It is the intent of these contract documents to have the Fire Protection Contractor provide systems and components that are complete and operational for the intended use. If the Fire Protection Contractor discovers a discrepancy or requires a clarification and has failed to notify the Architect / Engineer of the situation in accordance with Paragraph (A) above, the Fire Protection Contractor shall provide the specific systems or components within contract price.
- E. In cases covered by Paragraph (D) above, where the Fire Protection Contractor believes direction or clarification is required from the Architect / Engineer, the Fire Protection Contractor shall submit a sketch identifying the issue and a proposed solution. The Architect / Engineer will review proposed solution, note if necessary, and return.

1.5 PRE-BID SITE VISIT

- A. Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions. To schedule a site visit, contact Lori Lesnak (215-707-6333) at least 48 hours in advance of desired time of visit.
- B. Failure to advise Architect / Engineer of potential issues and / or concerns in writing during Pre-Bid Site Visit assumes Fire Protection Contractor accepts construction documents. No allowances will be made for difficulties encountered or any expense incurred because of existing conditions or items, which are visible or known to exist.

1.6 DEFINITIONS

- A. Specific terminology, as used herein, shall have the following meanings:
 - 1. "Furnish"...Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar subsequent requirements.
 - 2. "Install"...Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
 - 3. "Provide"...Furnish and install, complete and ready for intended use.
 - 4. "Concealed, Interior"...Concealed from view and protected from physical contact by building occupants.
 - 5. "Concealed, Exterior" ...Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures.
 - 6. "Exposed, Interior"...Exposed to view indoors (not concealed).
 - 7. "Exposed, Exterior"...Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
 - 8. "Finished Space" ...Space other than mechanical rooms, electrical rooms, pipe chases, unheated spaces immediately below roof, space above finish ceilings, crawl spaces, utility service tunnels, and interstitial spaces.
 - 9. "Conditioned"...Spaces directly provided with heating and cooling.
 - 10. "Unconditioned"...Spaces without heating or cooling including ceiling plenums.
 - 11. "Indoors"...Located inside the exterior walls and roof of the building.
 - 12. "Outdoors"...Located outside the exterior walls and roof of the building.
 - 13. "Atmosphere"...The same as outdoors.
 - 14. "Experienced" ...Skilled or Knowledgeable.
 - 15. "Appurtenance" ...Any component required for complete installation and operation.

1.7 GENERAL STANDARDS OF MATERIALS

- A. Materials shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five (5) years.
- B. Materials of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts, piping, and components.

- C. Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.
- D. With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.

1.8 PRODUCTS AND SUBSTITUTIONS

- A. Where a specific manufacturer's product is specified, the fire protection contract amount shall be based on that fire protection product (manufacturer and model) only. Any substitutions from the specified manufacturer and model shall be offered to the Architect / Engineer as a substitution request a minimum of ten (10) days prior to the bid date for review and approval. Fire protection substitutions will not be permitted or reviewed after the bidding phase without a substitution request included as part of the base bid.
- B. Where several manufacturers' products are specified, the contract amount shall be based upon the specified manufacturer and model only. Any substitutions from the specified manufacturers and models shall be offered to the Architect / Engineer as a substitution request a minimum of ten (10) days prior to the bid date for review and approval. Fire protection substitutions will not be permitted or reviewed after the bidding phase without a substitution request included as part of the base bid.
- C. Where only one manufacturer's product is specified, the associated systems have been designed on the basis of that product. Where several manufacturers' products are specified, the associated systems have been designed on the basis of the first named manufacturer's product. When products other than those used as the basis of design are substituted, the Fire Protection Contractor shall pay additional costs related to manufacturer and model submissions reviews, fire protection redesign, and modifications to design and / or installation required by the use of that product.

1.9 APPLICABLE CODES AND STANDARDS

- A. Materials furnished and work installed shall comply with applicable codes listed in Division 01, with the requirements of the local utility companies, and with the requirements of governmental departments or authorities having jurisdiction.
- B. Sprinklers, components, and appurtenances shall be both UL listed and FM approved whenever possible. The minimum standard is a UL listing.

1.10 CODES, PERMITS AND INSPECTIONS

- A. Fire protection materials shall comply with the International Building Code, the National Fire Protection Association, requirements of the local utility companies, governmental departments, and with authorities having jurisdiction. At a minimum the fire suppression work shall be provided in accordance with:
 - 1. NFPA 13 Standard for the Installation of Sprinkler Systems

- B. Materials and equipment furnished for the electrical portion of the fire protection systems shall comply with the National Electrical Code and bear the approval label of or shall be listed by the Underwriters' Laboratories, Inc.
- C. The building owner's insurance company is FM Global. The fire suppression system shall be provided following the additional recommendations of the insurance company. Drawings and hydraulic calculations shall be submitted to the Owner's insurance company for review and approval prior to the start of system installation.
- D. Fire Protection contractor shall provide labor, materials, services, apparatus and drawings required to comply with applicable laws, ordinances, rules and regulations, whether or not shown on the drawings and/or specified.
- E. Fire Protection contractor shall obtain and pay for required permits associated with approval and installation of fire protection systems and associated appurtenances.

1.11 GUARANTEES AND CERTIFICATES

- A. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated warrantee period.
 - 1. Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of the equipment testing, prior to occupancy will not be considered part of the warranty period.
- B. Prior to application for a "Certificate of Substantial Completion" of the fire protection systems, the Fire Protection Contractor shall provide in writing: [DESIGNER NOTE: Edit as required to suite project requirements]
 - 1. Description of each installed fire protection system and confirmation that it is operational for its intended purpose.
 - 2. Confirmation that fire protection equipment, pumps, components, and appurtenances have been installed and electrical connections have been made.
 - 3. Confirmation start-up and test sheets have been completed and submitted to the Architect / Engineer for review.
 - 4. Confirmation that access doors / panel are located to provide adequate access to fire protection components.
 - 5. Confirmation that pipe, valves, and equipment identification clearly indicates fire protection system type.
 - 6. Confirmation fire protection system piping, equipment, and components have been tested and cleaned.
 - 7. Confirmation that equipment has been provided in accordance with manufacturers requirements.
 - 8. Confirmation that tests, start-up procedures, and Owner training has occurred.
 - 9. Confirm all items indicated as part of Field Reports and Final Punch Lists have been completed and signed off.
 - 10. Final Operation and Procedure Manuals have been submitted and approved.

1.12 QUIET OPERATION AND VIBRATION CONTROL

- A. Equipment and associated items shall operate under conditions of load without sound or vibration deemed objectionable by the Architect. In the case of moving equipment, sound or vibration noticeable outside of the room in which it is installed, or noticeable within the room in which it is installed, shall be deemed objectionable. Sound or vibration deemed objectionable shall be corrected in an approved manner at no extra cost to the Owner. Vibration control shall be provided by means of approved vibration isolators and installed in accordance with the isolator manufacturer's recommendations.
- B. The sound pressure levels around fire protection equipment (fans, pumps, motors, etc.) in equipment spaces shall not exceed 85 dBA at any point three (3) feet from the equipment, with all equipment in the room operating. The sound criteria applies to the complete range of each piece of equipment.

1.13 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS [DESIGNER NOTE: REVISE TO CONFORM TO PROJECT LOCATION AND OWNERS DESIGN & CONSTRUCTION STANDARDS]

- A. Provide temporary fire protection required by NFPA and the City of Philadelphia. Provide shop drawings for temporary fire protection prior to the shop drawing submittal for the remaining fire protection system.
 - 1. Provide computer generated design drawings and hydraulic calculations as required by NFPA.
 - 2. Design drawings and hydraulic calculations shall be reviewed and approved by the Owner's Insurance Underwriter, the City of Philadelphia, and/or the Authority Having Jurisdiction.
- B. Plan installation of fire protection systems and connections to existing fire protection systems to insure minimum interference with regular operation of existing fire protection systems. Some temporary shutdown of existing fire protection systems may be required to complete the work.
- C. Submit to the Owner, Fire Code Officials, Fire Department, and other Authorities Having Jurisdiction in writing for approval, proposed dates, times, and duration of temporary shutdowns of existing fire protection systems.
 - 1. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner.
 - 2. Provide detailed written description of temporary shutdown requirements to Owner. The Owner reserves the right to require the Fire Protection Contractor to provide a walk-through prior to any shutdown.
 - 3. To minimize conflict with Owner's operation, shutdowns shall be planned to occur on weekdays between 3:00 p.m. and 11:00 p.m. or on weekends, as approved by the Owner.
 - 4. To insure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections.
 - 5. Provide temporary fire protection as directed by the Owner, Fire Code Officials, Fire Department, and other Authorities Having Jurisdiction during temporary outage.

- D. When fire protection system is restored after temporary outage, the Fire Protection Contractor shall:
 - 1. Perform necessary inspections and tests to verify that effected systems, equipment, components, and appurtenances are operational.
 - 2. Notify Building Owner, Fire Code Officials, Fire Department, and other Authorities Having Jurisdiction (in writing) that permanent fire protection system has been restored.

1.14 COORDINATION

- A. Coordinate and furnish in writing to the Architect / Engineer information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.
- B. Installation of permanent fire protection systems shall not proceed until coordination drawings are submitted by the Fire Protection Contractor to the Architect / Engineer for review and comment. No extra charges will be allowed for changes required to install fire protection system installation that occurred prior to review of the coordination drawing by the Architect / Engineer.
- C. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
- D. When work is installed without proper coordination, changes to this work deemed necessary by the Architect / Engineer shall be made to correct the conditions without extra cost to the Owner.
- E. The value of the coordination drawings shall be identified as a line item in the Schedule of Values. If the coordination drawings are not submitted as required, their value shall credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of coordination drawings shall be a minimum of two (2.0) percent of this Contract Amount.

1.15 SHOP DRAWINGS AND PRODUCT DATA

- A. Shop Drawing and Product Data Submittal Procedures
 - 1. Fire Protection Contractor shall prepare and submit electronic submittals.
 - a. Submit electronic submittals (PDF) files to the Owner Insurance Carrier, Fire Code Officials, Fire Department, and other Authorities Having Jurisdiction Commissioning Agency for review prior to any installation. The Owner may request paper copies of certain submittals for onsite coordination.
 - b. Permits, Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Permits, Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - 2. Product Data: Fire Protection Contractor shall compile information into a single submittal for each component, piece of equipment, and appurtenances.
 - a. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.

- b. Mark each copy of each submittal to show which products and options are applicable.
 - c. Include the following information:
 - 1) Submittal Package number and Submittal Item number.
 - 2) Manufacturer's catalog cuts.
 - 3) Manufacturer's product specifications.
 - 4) Statement of compliance with specified referenced standards.
 - 5) Testing by recognized testing agency.
 - 6) Application of testing agency labels and seals.
 - 7) Notation of coordination requirements.
 - 8) Availability and delivery time information.
 - d. For equipment, include the following in addition to the above, as applicable:
 - 1) Wiring diagrams showing factory-installed wiring.
 - 2) Printed performance curves.
 - 3) Operational range diagrams.
 - 4) Clearances required to other construction, if not indicated on accompanying Shop Drawings.
3. Shop Drawings: Fire Protection contractor shall provide project-specific fire protection system design based on their hydraulic calculation. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
- a. Include the following information:
 - 1) Submittal Package number and Submittal Item number.
 - 2) Identification of products.
 - 3) Schedules.
 - 4) Compliance with specified standards.
 - 5) Notation of coordination requirements.
 - 6) Notation of dimensions established by field measurement.
 - 7) Relationship and attachment to adjoining construction clearly indicated.
 - 8) Seal and signature of professional fire protection engineer.
 - b. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.
 - c. Upon receipt of Revise and Resubmit or Rejected shop drawings, the Fire Protection Contractor shall make all noted modifications then submit to Owner Insurance Carrier, Fire Code Officials, Fire Department, Authorities Having Jurisdiction, and Commissioning Agency within ten (10) days of receiving returned submittal.
 - 1) No fire protection work may proceed until shop drawings have been reviewed by Owner Insurance Carrier, Fire Code Officials, Fire Department, Authorities Having Jurisdiction, and Commissioning Agency.

1.16 OPERATION AND MAINTENANCE MANUAL

- A. Requirements for Operation And Maintenance Manuals

1. Organize the manual into separate sections by CSI number based on the table of contents of the project manual, for each system and subsystem, and a separate section for each piece of equipment not part of a system. The manual shall contain the following materials, in the order listed:
 - a. Title page.
 - b. Table of contents.
 - c. Manual contents:
 - 1) Operation data.
 - 2) Product maintenance data.
 - 3) Systems and equipment data
2. Title page shall include the following information:
 - a. Subject matter included in manual.
 - b. Name and address of Project.
 - c. Name and address of Owner.
 - d. Date of submittal.
 - e. Name and contact information for Fire Protection Contractor.
 - f. Name and contact information for Construction Manager.
 - g. Name and contact information for Design Professional.
 - h. Name and contact information for Commissioning Agent.
 - i. Name and contact information for Fire Protection Contractor's – Fire Protection Engineering who signed and sealed the contractors design.
 - j. Cross-reference to related systems in other operation and maintenance manuals.
3. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - a. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
4. Manual Contents: Arrange contents alphabetically by system, subsystem, and equipment. Assemble instructions for subsystems, equipment, and components of one system into a single binder.
5. Submit electronic (PDF) copy of the manual, to the Architect / Engineer for review.

1.17 AS-BUILT DOCUMENTS

A. As-Built Drawings:

1. Maintain one set of marked-up paper copies of the Fire Protection contract drawings and shop drawings on-site.

2. Fire Protection Contractor shall mark As-built Drawings daily to indicate the actual installation where installation varies from that shown on the construction documents.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
3. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Locations and depths of underground utilities.
 - d. Revisions to routing of piping.
 - e. Actual equipment locations.
 - f. Locations of concealed internal Fire Protection systems.
 - g. Changes made by Change Order or Change Directive.
 - h. Changes made following the Owner's written orders.
 - i. Details not on the original Contract Drawings.
 - j. Field records for variable and concealed conditions.
 - k. Record information on the Fire Protection work that is shown only schematically.
4. Mark As-Built sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Fire Protection work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SHOP DRAWING PREPARATION

- A. The Architect / Engineer will not review Fire Protection submittals that do not include the Fire Protection Contractor's approval stamp and will return them without action.
 1. The Architect / Engineer will review each submittal, make marks to indicate corrections or modifications required, and return to the Fire Protection Contractor. The Architect / Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action. Actions and their requirements are as follows:
 - a. REVIEWED: No correction or resubmissions required
 - b. REVIEWED AS NOTED: Contractor shall comply with noted corrections and comments but may proceed. If for any reason the Fire Protection Contractor cannot comply with the noted corrections, the Contractor shall resubmit with an explanation of why the corrections cannot be made or implemented. The Architect / Engineer or Owner will review the explanation and determine if it is satisfactory or if another solution is required.

- c. REVISE AND RESUBMIT: Contractor shall review the comments, revise the submittal accordingly and resubmit. Fire Protection work associated with submittal shall not proceed until all corrective actions are taken.
 - d. NOT REVIEWED: Submittals not required by to be reviewed by the Architect / Engineer.
- 2. Incomplete submittals are not acceptable and will be returned without review.
 - 3. Review of separate items or components that are not submitted as an assembly or system does not constitute review of the assembly or system in which the item functions.
 - 4. On projects that have commissioning, the Commissioning Authority will receive copies of the submittals through the Design Professional and will provide comments on the submittals via the Design Professional.

B. Contractors Submittal Schedule

- 1. The Fire Protection Contractor shall provide a shop drawing submittal schedule to the Architect / Engineer that indicates date for when all shop drawings, samples, material, and appurtenances will be submitted and date for when approval is required.

3.2 OPERATION AND MAINTENANCE MANUAL PREPARATION

A. Operation and Maintenance Documentation shall be provided for review.

- 1. Correct or modify the manual to comply with the Architect / Engineer and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect / Engineer and Commissioning Authority's comments and prior to commencing demonstration and training.

B. Product Maintenance Data: Assemble a complete set of maintenance data, in a separate section, within the Operation and Maintenance Manual, indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Operation and Maintenance Data: Assemble a complete set of operation and maintenance data, in a separate section, within the Operations and Maintenance Manual, indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

- 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
- 2. Prepare a separate section within the Operation and Maintenance Manual, for each system and subsystem, in the form of an instructional manual for use by operating personnel.

D. Manufacturers' Data: Where manual contain manufacturers' standard printed data; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

- 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

- E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in As-built Drawings to ensure correct illustration of completed installation.
- F. Do not use original project record documents as part of operation and maintenance manuals.

3.3 AS-BUILT DOCUMENTS

A. Recording and Maintenance

1. Maintain and submit written change log to the Architect / Engineer, monthly for review indicating items incorporated in contract turnover documents concurrent with progress of the Fire Protection work, including modifications, concealed conditions, field changes, product selections, and other notations incorporated.
2. Maintain one copy of each submittal during the construction period for contract turnover document purposes. Post changes and modifications to contract turnover documents as they occur; do not wait until the end of the Project.
3. Store turnover documents in the field office apart from the Contract Documents used for construction. Contract turnover documents are not to be used for construction purposes. Maintain turnover documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to contract turnover documents for the Architects / Engineers reference performance of Contract.
4. Before Fire Protection Contractor can request final payment, the project record drawings shall be submitted to the Architect / Engineer at the end of the project for review.

END OF SECTION 210000

SECTION 210500 – COMMON WORK RESULTS FOR FIRE PROTECTION SYSTEMS
GENERAL

RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

UNLESS NOTED OTHERWISE, ALL AREAS, SPACES AND ROOMS IN THE BUILDING SHALL BE FULLY SPRINKLERED TO COMPLY WITH NFPA-13 REQUIREMENTS FOR A 100% FULLY SPRINKLERED BUILDING. WHERE THERE ARE AREAS, SPACES AND/OR ROOMS PROHIBITED BY LOCAL JURISDICTION TO EXCLUDE SPRINKLERS SHALL BE FOLLOWED AND MAINTAINED. ACQUIRE DIRECTION FOR ALL THE PROHIBITED AREAS FOR SPRINKLER EXCLUSIONS FROM THE LOCAL AUTHORITIES HAVING JURISDICTION.

SUMMARY

This Section includes the following:

- Demolition.
- Installation of fire protection systems.
- Cutting and Patching.
- Waterproofing.
- Air Plenums.
- Electrical Connections.
- Accessibility.
- Cleaning, Protection and Adjustment.
- Special Tools.
- Welding.
- Dielectric Fittings
- Site Water Flow Test

DEMOLITION OF FIRE PROTECTION SYSTEMS

Review the construction documents, to determine the affected areas of the existing structure. Remove systems in the affected areas not to be reused including equipment, piping, controls, hangers, supports, etc.

Schedule demolition work with Owner.

Contractor shall be responsible to meet the requirements of NFPA 241 Standard for Safeguarding Construction, Alteration and Demolition Operations.

Demolition work involving electrical systems shall be coordinated prior to commencement of demolition work.

Existing piping shall be saw-cut, not broken, at point where piping connects to existing.

Where demolition of existing systems, equipment, and associated appurtenances occurs, all such service shall be properly terminated in an approved manner to allow affected systems to remain in operation.

The Owner has the right-of-first-refusal for any items to be demolished, salvaged or removed. The Contractor and Owner shall jointly review the space where demolition is to occur and identify items the Owner elects to retain prior to demolition and removal. Remove items to be retained by the Owner and deliver them to the location directed by the Owner within a [1] mile radius of the project. Promptly remove and properly dispose of materials, equipment, piping, debris, etc., which is not specified for reuse, storage, or retainage by Owner.

Provide support as required for any existing piping and equipment support affected by demolition.

Where piping, serves area affected by demolition and other areas of building not affected by demolition, reconnect piping, serving unaffected areas to existing or new systems serving affected areas.

INSTALLATION OF FIRE PROTECTION SYSTEMS

Provide isolation valves, unions, flanges, traps, and appurtenances as required for a complete operational fire protection system.

Prior to commencing installation of fire protection rough-in, coordinate final reviewed equipment shop drawings. Revise rough-in and final connections as required to correspond with the requirements of actual equipment, components, and appurtenances that will be installed.

Arrange fire protection piping and connections to allow for easy access to other systems.

CUTTING AND PATCHING

Provide cutting, patching, and holes, and necessary to install the work specified herein.

Use materials identical to in-place materials.

For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials, unless specified otherwise in other Sections.

Fire Rated Elements: Do not cut and patch fire rated elements (i.e. floors, walls, roofs, shafts, etc.) in a manner that results in reducing their capacity to perform as intended or that results in decreased fire rating.

Where cutting and patching are required of fire rated elements and the resulting cutting reduces the capacity of the system to perform as intended, the Fire protection Contractor performing the cutting is responsible for repairing the assembly or for providing an engineering judgment to maintain the design intent rating.

Fire protection Contractor shall submit repair or engineering judgment to the Authorities Having Jurisdiction and the Architect / Engineer. All parties must approve the work prior to proceeding with the Work.

No structural members shall be cut without prior approval of the Architect / Engineer.

Provide ceiling removal and replacement where work above ceilings is required. Replace ceiling components damaged in the process.

Documentation of effected systems shall be provided to the Architect / Engineer and Owner prior to any cutting and patching:

List any services / systems that cutting and patching will disturb or affect.

List services / systems that will be need to be relocated and those that will be temporarily out of service. Indicate how long services / systems will be disrupted.

Structural Elements: Where cutting and patching involve structural elements, submit details and exact locations to the Structural Engineer for review prior to cutting.

WATERPROOFING

Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect prior to performing the work. Furnish necessary sleeves, caulking and flashing required to make openings absolutely watertight.

AIR PLENUMS

Plenums which are used as part of an air distribution system as defined by NFPA 90, shall be provided with materials tested in accordance with NFPA 255, ASTM E 84, and rated for air plenum installation. The Contractor shall be responsible to utilize the correct materials in ceiling space used for environmental air purposes.

Fire Protection Contractor shall utilize plenum rated materials, equipment, and appurtenances in ceiling cavities used for environmental air purposes.

ELECTRICAL CONNECTIONS

Regardless of voltage, provide control wiring, interlock wiring, and equipment control wiring for fire protection equipment provided under Division 21.

Coordinate to ensure that electrical devices furnished or provided are compatible with the electrical systems used.

Confirm final location of electrical equipment to be installed in the vicinity of fire protection system.

ACCESSIBILITY

- A. Coordinate to ensure the sufficiency of the size of shafts, chases, the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.
- B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights, curtain tracks, speakers, etc. Equipment requiring access shall include, but is not necessarily limited to, valves, traps, pumps, drain points, etc.
- C. Indicate the locations of access doors for each concealed valve, piece of equipment, components, or other device concealed behind finished construction and requiring service on the coordination drawings.

CLEANING, PROTECTION AND ADJUSTMENT

Cleaning:

Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed. Clean, polish, and leave equipment, accessories, and trim in first-class condition.

Protection of Surfaces:

Protect surfaces from damage during the construction period.

Provide plywood or similar material under equipment or materials stored on floors or roofs.

Provide protection in areas where construction may damage surfaces.

Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Owner and Architect.

Protection of Services

Protect services from damage during the construction period.

Repair, replace and maintain utilities, facilities or services (underground, above ground, interior or exterior) damaged, broken or otherwise rendered inoperative during the course of construction.

Services damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Owner and Architect.

Protection of Equipment and Materials

Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on site in open or unprotected areas, equipment and material shall be kept off the ground and out of standing water by means of pallets or racks, and covered with tarpaulins.

Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Architect or manufacturer the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.

During the construction period, protect piping, fittings, valves, equipment, and associated appurtenances from damage and dirt. Each system of piping shall be flushed to remove grit, dirt, sand, and other foreign matter for as long a time as required to thoroughly clean the systems.

Adjustment

Provide factory-lubricated bearings for equipment. Before initial startup of equipment, inspect and verify bearings for proper amounts of lubricant. If required, provide proper amounts of lubricant in accordance with manufacturer's recommendations.

SPECIAL TOOLS

Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

WELDING

General Requirements

This paragraph covers the welding of systems. Deviations from applicable codes, approved procedures and approved shop drawings shall not be permitted. Materials or components with welds made off site shall not be accepted if the welding does not conform to the requirements of this specification. Develop and qualify procedures for welding metals included in the work. Certification testing shall be performed by an approved independent testing laboratory. Bear costs of such testing.

Certified welders, previously certified by test, may be accepted for the work without re-certification provided that all of the following conditions are fulfilled:

Submit copies of welder certification test records in accordance with this Division and Division 01 requirements.

Testing was performed by an independent testing laboratory.

The welding procedures and welders are certified in accordance with the "ASME Boiler and Pressure Vessel Code," and base materials, filler materials, electrodes, equipment, and processes conform to the applicable requirements of this specification.

Certification has been within a one (1) year period from the start of the project.

Filler metals, electrodes, fluxes and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to assure safe handling.

Submit welding certificates for review. Each welder assigned to work covered by this specification shall be certified by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires.

Before assigning welders to the work, provide the architect with their names, together with certification that each individual is certified as specified. No welding work shall start prior to submissions. The certification shall state the type of welding and positions for which each is certified, the code and procedure under which each is certified, date certified, and the firm and individual certifying the certified tests.

Each welder shall be assigned an identifying number, letter, or symbol that shall be used to identify his welds. A list of the welders' names and symbol for each shall be submitted. To identify welds, either written records indicating the location of welds made by each welder shall be submitted, or each welder shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers shall be confined to the weld reinforcing crown, preferably in the finished crater.

1.2 DIELECTRIC FITTINGS

- A. Ferrous to non-ferrous pipe connections shall be made with threaded, soldered, plain, or welded end connections that match piping system material. Dielectric fittings shall prevent any electrolytic action between dissimilar materials.

1.3 SITE WATER FLOW TEST

- A. The fire protection contractor shall conduct a fire pump flow test and provide flow test report certified by a professional engineer to the Architect/Engineer for review. The contractor shall use the flow test data to perform the hydraulic calculations.
- B. Flow test information listed on the drawings is included for general information only.

PRODUCTS

PROTECTION OF ELECTRICAL EQUIPMENT

Plan and arrange overhead piping to avoid dedicated electrical space that may include motors, controllers, switchboards, panel boards, or similar equipment.

Dedicated electrical space is equal to the width and depth of the electrical components and extends from the floor to a height of 6 feet above the electrical components or to the structural ceiling, whichever is lower. No piping, leak detection apparatus, equipment, components or associated appurtenances foreign to the electrical installation shall be located in the dedicated electrical space.

Dropped, suspended, or any other type of ceiling that does not add strength to the building structure cannot be provided as a separation between dedicated electrical space for the installation of foreign components within the dedicated electrical space.

ACCESS DOORS

Access doors shall be a minimum of 18 inch x 18 inch and manufactured as an integral unit, complete with all parts, accessories and ready for installation.

Access doors and frames shall be of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.

Frames shall be fabricated from 16-gauge steel.

Fabricate frame with exposed flange nominal 1 inch wide around perimeter of frame for units installed in the following construction:

Exposed Masonry

For gypsum drywall or veneer gypsum plaster, furnish perforated frames with drywall bead.

For installation in masonry construction, furnish frames with adjustable metal masonry anchors.

For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

Flush Panel Doors shall be fabricated from not less than 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175°. Finish with manufacturer's factory-applied prime paint.

For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.

Locking devices shall be flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

Manufacturers:

Bar-Co., Inc.
J. L. Industries
Karp Associates, Inc.
Nystrom, Inc.

PIPING WELDING

Welding materials shall comply with the "ASME Boiler and Pressure Vessel Code." Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a certified welder using qualified welding procedures.

DIELECTRIC FITTINGS

Dielectric unions shall be factory – fabricated assemblies with a minimum working pressure as required to suit system pressures.

Dielectric flanges shall be factory – fabricated, companion flange assemblies with a minimum working pressure as required to suit system pressures.

Dielectric flange kits shall be field – fabricated with a minimum working pressure as required to suit system pressures. Kit shall include flanges, full face type phenolic gasket, phenolic bolt sleeves, phenolic washers, and steel backing washers.

Dielectric couplings shall be galvanized steel with inert and noncorrosive, thermoplastic lining, threaded ends and a minimum working pressure as required to suit system pressures.

Dielectric nipples shall be electroplated steel nipple with inert and noncorrosive, thermoplastic lining, plain, threaded, or grooved ends and a minimum working pressure as required to suit system pressures.

Manufacturers

Watts Industries
Zurn Industries
Sioux Chief Industries

EXECUTION

ACCESS DOORS

Coordinate access doors locations with all trades during coordination drawing phase.

WELDING

Perform welding in accordance with qualified procedures using certified welders. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. Welding of hangers, supports, and plates to structural members shall conform to AWS specifications.

Field bevels and shop bevels shall be by mechanical means or by flame cutting. Where beveling is by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding. Beveling shall conform to ANSI B31.1 and AWS B3.0.

Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening shall not be permitted. Welders responsible for defective welds must be re-certified.

Store electrodes in a dry heated area, keep free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

END OF SECTION 210500

SECTION 210516 EXPANSION FITTINGS AND LOOPS FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Systems used on this project shall be in accordance with Building Owner's Design Standards. Consult the Owner, the Architect and the Engineer for further information and prior to any final product purchase.
- C. The building is classified by the Structural Engineer as Seismic Design Category – B. However; The Fire Protection System being classified as life-safety system shall be required of having seismic bracing system and where systems cross Building Expansion Joints, piping shall cross with appropriate expansion connection and shall be supported with appropriate bracing.

1.2 SUMMARY

- A. Section Includes:
 - 1. Flexible pipe connectors.
 - 2. Expansion joints.
 - 3. Expansion compensators.
 - 4. Pipe alignment guides.
 - 5. Swivel joints.
 - 6. Pipe anchors.

1.3 REFERENCES

- A. General: Comply with appropriate standards.
 - 1. American Welding Society: AWS.
 - 2. Underwriters' Laboratories: U.L.

1.4 DESIGN REQUIREMENTS

- A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.
- B. Expansion Compensation Design Criteria:
 - 1. Installation Temperature: 50 degrees F.
 - 2. Fire Protection System Temperature: 75 degrees F.
 - 3. Safety Factor: 20 percent.

1.5 SUBMITTALS

- A. Submit data on all materials.
- B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion

joints, expansion compensators, loops, offsets and swing joints. Drawings shall be sealed by a registered professional engineer. Include information for piping expansion compensation in shop drawings for all fire suppression piping system as needed.

- C. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- D. Design Data: Indicate criteria and show calculations. Submit sizing methods calculations sealed by a registered professional engineer.
- E. Manufacturer's Installation Instructions: Submit special procedures.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Welders' Certificate: Include welders' certification of compliance with AWS D1.1.
- H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.
- I. Operation and Maintenance Data: submit adjustment instructions.

1.6 WARRANTY

- A. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
 - 1. Mason Ind.
 - 2. Vibrex-Sausse.
 - 3. Metraflex.
- B. Steel Piping:
 - 1. Inner Hose: Carbon Steel, Stainless Steel or Bronze.
 - 2. Exterior Sleeve: Double braided stainless steel or bronze.
 - 3. Pressure Rating: 200 psig WOG and 250 degrees F.
 - 4. Maximum offset: 1 inch on each side of installed center line.
- C. Copper Piping:
 - 1. Inner Hose: Bronze
 - 2. Exterior Sleeve: Braided bronze.

3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Maximum offset: 1 inch on each side of installed center line

2.2 EXPANSION JOINTS

A. Manufacturers:

1. Mason Ind.
2. Vibrex-Sausse.
3. Metraflex.

B. Stainless Steel Bellows Type:

1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Maximum Compression: 1-3/4 inch.
3. Maximum Extension: 1/4 inch.
4. Application: Steel piping 3 inch and smaller.

C. External Ring Controlled Stainless Steel Bellows Type:

1. Pressure Rating: 225 psig and 70 degrees F.
2. Maximum Compression: 1-1/4 inch.
3. Maximum Extension: 5/16 inch.
4. Maximum Offset: 5/16 inch.
5. Accessories: Internal flow liner.
6. Application: Steel piping 3 inch and larger.

D. Double Sphere, Elbow or Flexible Compensators:

1. Body: Teflon or Neoprene and nylon.
2. Working Pressure: 225 psi.
3. Maximum Temperature: 80 degrees F.
4. Maximum Compression: 1-1/8 inch.
5. Maximum Elongation: 7/8 inch.
6. Maximum Offset: 7/8 inch.
7. Maximum Angular Movement: 30 degrees.
8. Accessories: Control rods or Control cables.
9. Application: Steel piping 2 inch and larger.

E. Two-ply Bronze Bellows Type:

1. Construction: Bronze with anti-torque device, limit stops, internal guides.
2. Pressure Rating: 200 psi WOG and 250 degrees F.
3. Maximum Compression: 1-3/4 inch.
4. Maximum Extension: 1/4 inch.
5. Application: Copper piping.

F. Copper with Packed Sliding Sleeve:

1. Maximum Temperature: 250 degrees F.
2. Copper or steel piping 2 inches and larger.
3. Application: Copper or steel piping 2 inch and larger.

G. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation,

minimum 3 inch travel.

- H. Swivel Joints: Fabricated steel Bronze Ductile Iron Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) O-ring seals.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
- B. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- C. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.
- D. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints as required.
- E. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.
- F. Install expansion joints where system piping cross building expansion joints. Piping shall cross with appropriate expansion loops and flexible connectors and shall be supported with appropriate seismic bracing in accordance with all guidelines and governing codes and regulations.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 210516

SECTION 210519 – FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Systems used on this project shall be in accordance with Owner's Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner prior to final product purchase.
- C. All components shall be UL listed and FM approved.

1.2 GENERAL

- A. Provide fire suppression systems and equipment as shown on the drawings and / or as specified herein.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Sprinkler system valves.
 - 2. Switches and alarm connections.
 - 3. Floor control assembly with test and drains.

PART 2 - PRODUCTS

2.1 SPRINKLER SYSTEM VALVES

- A. All Control valves shall be indicating type and shall be provided with tamper switches.
- B. Butterfly Valves
 - 1. Valves size 2-1/2 inches and smaller shall be provided with wheel operator, integral tamper resistant, two SPDT monitor switch for interconnection with building fire alarm system. (Wiring shall be under Division 28.)
 - 2. Manufacturer and Model (2-1/2 inches and smaller)
 - a. Milwaukee Valve Company - Model BB SCS.
 - b. Nibco Inc. - Model KT/KG 505 W 8 TS 2M.
 - c. Victaulic Company – Model Series 728 fire ball valve.
 - 3. Manufacture and Model (3 inches and larger)
 - a. Tyco – Model BFV-N
 - b. Kennedy – Figure 01 Series
 - c. Nibco - Model GD 4765 8N.

- d. Victaulic – Model Series 705W butterfly valve.

C. Ball Valves

- 1. Sprinkler system valves one inch and smaller shall be FM approved ball valves.

- a. Manufacturer and Model

- 1) Nibco - Model KT 585 70 UL.
- 2) Anvil - Model 171.
- 3) United - Model 80SS.

D. Existing Valves

- 1. Verify proper operation of existing control valve(s). Provide testing of existing tamper switch(s) to verify operation and compatibility with proposed alarming system.
- 2. Coordinate testing with the Owner's maintenance and fire alarm personnel.

E. Check Valve

- 1. Check valve shall be provided in the fire protection system where flow direction is regulated.

- a. Manufacture and Model

- 1) Viking- Model D-1
- 2) Victaulic- Series 717
- 3) Tyco- Model CV-1F

- 2. Riser swing check valve shall be provided at the base of all fire protection system risers.

- a. Manufacture and Model

- 1) Viking- Model F-1
- 2) Victaulic- Series 717R
- 3) Tyco- Model CV-1FR

2.2 SWITCHES AND ALARM CONNECTIONS

A. Flow Alarm Switch

- 1. Each sprinkler branch piping connection to the standpipe, shall be provided with a UL listed and FM approved vane type flow alarm switch immediately downstream from the monitored flow control valve. Flow alarm switches shall be rated for 450 PSI. Flow switches shall be provided with 2 sets of single throw double pole contacts with terminals for wiring to the building fire alarm system. Wiring shall be under Division 28.
- 2. Contact closure shall have an adjustable response retard from 0 90 seconds and be set for 30 seconds from the start of flow through inspector's test connection (1/2 inch orifice) with valve fully open.
- 3. Coordinate testing with Owner's maintenance and fire alarm personnel.

4. Manufacturer and Model
 - a. Potter Electric Signal Co - Model VSR
 - b. System Sensor - Model WFD

B. Valve Tamper Switch

1. At each control valve in the fire protection piping that can render the system out of commission, provide a UL listed/FM approved tamper switch. Tamper switches shall be provided with two sets of single pole double throw contacts and terminals for wiring to the building fire alarm system. Wiring shall be under Division 28.
2. Manufacturer and Model
 - a. Potter Electrical Signal Co. - Model OSYSU 2 for OS and Y valves, or PCVS 2 for butterfly valves.
 - b. System Sensor - Model OSY2. for OS and Y valves, or PIBV2 for butterfly valves.

2.3 FLOOR CONTROL ASSEMBLY

- A. Provide at project floor level, and as indicated on the drawings, a floor control valve assembly comprising of a control valve with supervisory tamper switch, check valve, pressure gauge and supervisory water flow switch. Provide drain riser manifold and inspector's test and drain assembly with sight glass, union and bypass valve. The floor control assembly shall have threaded connections and be UL listed and FM approved. The outlet of the test and drain assembly shall be piped to a drain riser.
1. Manufacturer and Model (Riser Manifold)
 - a. Victaulic - Model 747
 - b. Tyco – Model 513
 - c. AGF Manufacturing - Model 8011
 - d. Viking – Easypac Riser Assembly Model DN
 2. Manufacturer and Model (Test and Drain)
 - a. Victaulic – Model Test Master II Style 720
 - b. Tyco - Model F350
 - c. AGF Manufacturing - Model 2511A

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide pressure relief valve, with discharge piped to a building drain, at the Inspector's test connection for all grided systems to prevent over pressurization.

END OF SECTION 210519

SECTION 210529 – FIRE PROTECTION HANGERS, SUPPORTS AND SLEEVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Systems used on this project shall be in accordance with Owner's Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner prior to final product purchase.

1.2 GENERAL

- A. Provide fire suppression systems and equipment as shown on the drawings and / or as specified herein.
- B. SUMMARY
- C. This Section includes the following:
 - 1. Hangers and Support.
 - 2. Sleeves.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design all pipe hangers, equipment supports and concrete anchors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
- C. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents and test water.
- D. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components in accordance with the gravity, seismic and wind load combinations, given in ASCE 7, and the Structural Design Criteria.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Powder-actuated fastener systems.
 - 3. Pipe positioning systems.
 - 4. Concrete Inserts

- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers. Include Product Data for components.
 - 2. Metal framing systems. Include Product Data for components.
 - 3. Fiberglass strut systems. Include Product Data for components.
 - 4. Pipe stands. Include Product Data for components.
 - 5. Equipment supports.
- C. Delegated-Design Submittal: For pipe hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." AWS D1.4, "Structural Welding Code--Reinforcing Steel." ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
 - 4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. General
 - 1. Sprinkler piping shall be supported independently from the building structure and be capable of supporting the water filled pipe plus 250 pounds at the hanger support. Trapeze hangers shall be used when necessary to transfer loads to appropriate structural members.
 - 2. Specified bracket clamp and rod sizes are minimum size. Support and hanger design shall include a safety factor of 5.
 - 3. Plastic-coated hangers and clamps shall be provided for copper pipe unless shields are provided between hangers or clamps.
 - 4. Provide steel required for support of pipes other than steel shown on the structural drawings.
 - 5. Chain straps, perforated bars, wire hangers or expansion shields are not permitted.
 - 6. Inserts for piping shall be of a type which shall not interfere with structural reinforcing and which shall not displace excessive amounts of concrete.
 - 7. Piping located near floors which can be supported from floor or walls shall be provided with approved floor stands, wall brackets, roller supports, masonry piers or similar items.
 - 8. Resilient hangers and isolation devices shall be provided on piping connected to rotating equipment (such as pumps) and on other piping which may vibrate and create audible noise.

9. Rigid hangers for horizontal piping shall provide a means of vertical adjustment after erection.
10. Lateral sway bracing shall be provided on feed mains and cross mains regardless of size and branch piping 2-1/2 inches and larger.
11. Hangers or supports shall be provided as required to stabilize and re-support any existing piping that is to remain and be reused in areas affected by demolition.

B. Manufacturers and Model

Hanger Type	PHD	Erico	B-Line	Anvil International
Beam clamp	250-1	200	B351L	Figure 95
Adjustable swivel ring hanger	141	115	B3170NF	Figure 69
Standard clevis hanger	450	400	B3100	Figure 260
Standard iron pipe riser clamp	550	510	B3373	Figure 261
Standard U-bolt	90	150	B3188	Figure 137
Welded side beam attachment	920	325	B3060	Figure 206

C. Hanger Rod Schedule

Pipe Size	Minimum Rod Size
Up to 4 inches	3/8 inch diameter
5 inches to 8 inches	1/2 inch diameter
10 inches to 12 inches	5/8 inch diameter

D. Fasteners and Anchors

1. Cast-In-Place Bolts

- a. Anchors, Bolts, Nuts, and Washers: Bolts and studs, nuts, and washers shall conform to ASTM A307, Grade A, and ASTM A449, ASTM A563, and ASTM F436, as applicable.
- b. Hot-dip galvanized bolts and studs including associated nuts and washers in accordance with ASTM A153.

2. Drilled-In Anchors

- a. Wedge Anchors: Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers.
 - 1) Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193.
The following applies to interior applications in a non-corrosive environment.
 - 2) Interior Use: Provide carbon steel anchors with zinc plating in accordance with ASTM B633.

Proper consideration should be given to contact between galvanically dissimilar metals. AISI 316 should not be used where pitting corrosion is a concern.

- 3) Exterior Use: Provide stainless steel anchors. Stainless steel anchors shall be AISI Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
 - 4) Manufacturers:
 - a) Hilti
 - b) Fastenal
- b. Cartridge Injection Adhesive Anchors: Threaded steel rod, inserts or reinforcing dowels, complete with nuts, washers, polymer or hybrid mortar adhesive injection system, and manufacturer's installation instructions.
The following paragraph applies to interior applications in a non-corrosive environment.
- 1) Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, or carbon steel HIT TZ rods conforming to ASTM A510 with chemical composition of AISI 1038.
Proper consideration should be given to contact between galvanically dissimilar metals. AISI 316 should not be used where pitting corrosion is a concern.
 - 2) Exterior Use: Provide stainless steel anchors. Stainless steel anchors shall be AISI Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified.
 - 3) Reinforcing dowels shall be A615 Grade 60.
 - 4) Manufacturers:
 - a) Hilti
 - b) Fastenal
- c. Capsule Anchors: Threaded steel rod inserts and reinforcing dowels with 45 degree chisel point, complete with nuts, washers, glass or foil capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, and manufacturer's installation instructions.
The following applies to interior applications in a non-corrosive environment.
- 1) Interior Use: Unless otherwise indicated on the Drawings, provide chisel-pointed carbon steel rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633.

Proper consideration should be given to contact between galvanically dissimilar metals. AISI 316 should not be used where pitting corrosion is a concern.

- 2) Exterior Use: As indicated on the Drawings, provide chisel-pointed stainless steel anchors. Stainless steel anchors shall be AISI Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified.
- 3) Reinforcing dowels shall be A615 Grade 60, with 45-degree chisel-points at embedded end.
- 4) Manufacturers:
 - a) Hilti
 - b) Fastenal

2.2 SLEEVES

- A. Provide sleeves for piping passing through walls, floors, ceilings, roofs, equipment, structural members, and other building parts. Sleeves shall be securely fastened to the assembly penetrated.

1. Through penetration of fire-resistance-rated walls

- a. Annular space between sleeves and pipes shall be protected by an approved UL listed through - penetration fire stop system installed and tested in accordance with ASTM E814, with a minimum positive pressure differential of 0.01 inch of water and shall have an F rating of not less than the required fire resistance rating of the wall penetration.
- b. Sealant in one-hour and two-hour walls shall be UL listed and installed in accordance with manufacturer's recommendations.
- c. Manufacturers:
 - 1) Pro Set
 - 2) Hilti

2. Through penetration of fire-resistance-rated floor and roof assemblies

- a. Annular space between sleeves and pipes shall be protected by an approved UL listed through - penetration fire stop system installed and tested in accordance with ASTM E814, with a minimum positive pressure differential of 0.01 inch of water. The system shall have an F rating and a T rating of not less than one hour but not less than the required rating of the floor penetration
- b. Sealant in one-hour and two-hour floors shall UL listed and installed in accordance with manufacturer's recommendations.
- c. Manufacturers:
 - 1) Pro Set
 - 2) Hilti

3. Through penetrations of non-fire-resistance-rated walls and floors.
 - a. Annular space between sleeves and pipes in non-fire-resistance-rated assemblies shall be filled or tightly caulked in an approved manor.
 - b. Sealant for general purpose use and for Kitchen, Food Preparation, and Dining areas shall be provided in accordance with manufacturer's recommendations.
 - c. Manufacturers:
 - 1) Pro Set
 - 2) Hilti
4. Through penetrations of exterior non-fire-resistance walls.
 - a. Provide molded non-metallic high density polyethylene sleeves (HDPE) with integral hollow, molded water-stop ring four inches larger than the outside diameter of the sleeve itself.
 - b. Provide mechanical seal, consisting of rubber links shaped to continuously fill the annular space between the pipe and the wall opening.
 - 1) Pressure plates shall be molded of glass reinforced nylon.
 - 2) Hardware shall be mild steel with a 60,000 psi minimum tensile strength and 2-part Zinc Dichromate coating per ASTM B-633 and Organic Coating, tested in accordance with ASTM B-117 to pass a 1,500-hour salt spray test or 316 Stainless Steel.
 - 3) Coloration shall be throughout elastomer for positive field inspection.
 - 4) Each link shall have permanent identification of the size and manufacturer's name molded into the pressure plate and sealing element.
 - c. Manufacturer:
 - 1) Link Seal
- B. Pipes through or under footing or foundation walls shall be provided with a pipe sleeve built into the foundation wall. The pipe sleeve shall be two pipe sizes greater than the pipe passing through the wall.
- C. Piping shall be installed to prevent strains and stress that exceed the structural strength of the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction, and structural settlement.
- D. Where piping is provided through holes, notches in studs, joists, rafters, or other similar members and is less than 1.5 inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 0.062 inch thick steel and shall cover the area of the pipe that is closer than 1.5 inches from edge.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install entire sprinkler system hanger and supports shall be provide in accordance with NFPA 13: Standard for the Installation of Sprinkler Systems.

END OF SECTION 210529

SECTION 210553 – IDENTIFICATION FOR PIPING, VALVES AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Systems used on this project shall be in accordance with Owner's Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner prior to final product purchase.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Pipe identification labels
 - 2. Stencils
 - 3. Valve tags
 - 4. Valve schedules and charts
 - 5. Equipment labels and name plates
 - 6. Ceiling markers for concealed equipment, valves and devices
 - 7. Warning signs and labels

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PIPE IDENTIFICATION LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
- E. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
- F. Lettering Size: At least 1-1/2 inches high.
- G. Interior
 - 1. Pipe bands indicating contents and flow direction shall be flexible vinyl film with acrylic pressure sensitive adhesive suitable for pipe surface temperatures of -40°F to 220°F.
 - 2. Manufacturer and Model
 - a. Seton – Opti-Code
 - b. Brady – Model B-946
 - c. Bunting, Inc.
- H. Exterior
 - 1. Pipe bands indicating contents and flow direction shall be snap-on markers consisting of a surface-printed and overcoat-protected vinyl base material suitable for pipe surface temperatures from -40°F to 150°F.
 - 2. Manufacturer and Model
 - a. Seton – Weather Code
 - b. Brady – Model B-915
 - c. Bunting, Inc
- I. Blow Grade
 - 1. Metallic Pipe - Underground metallic pipe shall be identified by underground warning tape. Tape shall be 0.004 inch thick, 6 inch wide polyethylene tape, color coded, with continuous message stating "Caution" and stating which type of pipe is buried.
 - a. Manufacturer
 - 1) Seton
 - 2) Brady
 - 3) Bunting, Inc

- C. Pipe marking shall comply with ANSI A13.1 Scheme for the Identification of Pipe Systems. Markers shall be in compliance with respect to:

1. Marker length
2. Background color
3. Letter color
4. Letter size

2.3 VALVE TAGS

- A. Brass with stamped or engraved numbers and letters (black-filled), 1-1/2 inch square with 1/2 inch numbers and 1/4 inch letters.
- B. Fastening shall be by brass "S" hooks, brass jack chains, or brass ball chains.
- C. Manufacturer
1. Seton
 2. Brady
 3. Bunting

2.4 VALVE SCHEDULES AND CHARTS

- A. Valve charts shall be of size sufficient to provide valve number, size, function, and location. Chart shall have key plan denoting approximate valve location.
- J. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
- K. Valve charts shall be framed in wood or metal frames with Plexiglas cover.
- L. Charts and diagrams, (i.e., drawings, listing and valves) shall be provided in duplicate. Charts and lists shall include the following items:
1. Valve number.
 2. Utility being transferred.
 3. Valve location.
 4. Area or equipment being serviced (example: AHU-G-4-101).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 PIPE IDENTIFICATION AND LABEL INSTALLATION

A. Pipe identification shall be as follows:

1. Piping shall have direction of flow arrows matching the legend and background colors adjacent to each marker and at branches.
2. Pipe identification shall be placed on piping at 20 foot maximum intervals. In addition, wherever a pipe passes through a wall, floor, or ceiling, it should be identified on each side of the wall, floor, or ceiling.
3. Where pipe insulation or pipe is to be painted, it should be painted to match the background color of its contents.

B. Colors for pipe marking systems shall be in accordance with ANSI standards.

C. Underground piping shall be identified with identification tape continuously while below grade.

1. Depth of tape shall be 12 inches below grade for piping buried up to 30 inches deep, and 18 to 24 inches above pipe for depths below 30 inches deep.

3.2 VALVE TAGS INSTALLATION

A. Provide identification tags for valves including control valves. Shutoff valves serving individual fixtures and equipment shall not be tagged.

B. Valves shall have brass tags indicating system and valve number.

C. Provide valve charts in an approved location secured to wall.

D. Include a copy of the valve chart in each operation and maintenance manual.

E. All valves located above ceilings shall be marked on the ceiling with valve identification pins.

END OF SECTION 210553

SECTION 210700 – SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Systems used on this project shall be in accordance with Owner's Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner prior to final product purchase.
- C. Unless required by the Local Authorities Having Jurisdictions and where the building is classified and categorized by the Structural Engineer as Seismic Design Category, all Systems shall be designed with seismic bracing. Where systems cross Building Expansion Joints, piping shall cross with appropriate expansion connections and shall be supported with appropriate bracing as described in related sections of the specifications.

1.2 GENERAL

- A. Provide fire suppression systems and equipment as shown on the drawings and / or as specified herein.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. System design.
 - 2. Sprinklers.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Engineering Responsibility: Design and preparation of working plans, shop drawings, calculations, field test reports, pipe support systems and trapeze by a qualified professional engineer.
 - 2. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of piping, hangers and supports that are similar to those indicated for this project in material, design and extent.

3. Installer's responsibilities include designing, fabricating and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of flow test.
 - a. The contract drawings show the intent of the design and shall be used to establish the Basis of Design. The contract drawings shall not be used as the basis for final installation and construction of the Fire Protection System.
 - b. The Fire Protection Contractor shall assume all responsibilities in providing a design and installation of the Fire Protection System in full compliance with NFPA-13, NFPA 14 and NFPA 20 and any required governing codes and regulations including but not limited to the requirements of the Local Authority having Jurisdiction.
 - c. The Fire Protection System Contractor shall assume all responsibilities for coordinating with all other trades and disciplines for a fully functional, operational, code compliant and approved system.
 - d. The project shall be 100% fully sprinklered with respect to all governing codes and regulations. Where there are any areas that sprinkler heads and piping are not indicated on the drawings, the Fire Protection Contractor shall notify the discrepancy in writing to the attention of the Engineer for a clarification and provide budget for the discrepancy prior to submitting the bid.
 - e. Where there are discrepancies in sizes or quantities between the plans the riser diagrams and actual field conditions, the contractor shall notify the discrepancy in writing to the attention of the Engineer for a clarification. For pricing purposes the contractor shall make allowance for the more stringent of the sizes and quantities in the budget.
 - f. The locations of the existing services are believed to be as indicated on the drawings. The contractor shall verify the actual location of these services and notify the Engineer of any discrepancies prior to commencing any work.
4. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - a. NFPA 13, "Installation of Sprinkler Systems."

- b. NFPA 14, "Installation of Standpipes and Hose Systems."
- c. NFPA 20, "Installation of Stationary pumps for fire protection".

1.5 COORDINATION

- A. Revise this article to delete or add types of construction that penetrate or are supported by ceilings.
- B. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- C. Specifications are of simplified form and include incomplete sentences. Words or phrases such as "the contractor shall," "shall be," "furnish," "provide," "a," "the," and "all" have been omitted for brevity.
- D. Coordinate all new fire protection work with all existing and/or new ductwork, piping and utilities of any systems. Drawings are diagrammatic and show the intent of the design. Reroute any piping around existing and/or new systems including all required fittings and supports to make the installation of the piping and sprinkler heads possible. Reseal any fire and/or smoke rated penetrations that have been affected as a result of the modification.
- E. Remove, relocate and reconnect any existing piping that shall remain active in service which interferes with the new architectural layout, ceiling devices, equipment, new ceiling heights and any unforeseen condition arising from the new modifications. All existing and new piping shall be located concealed behind new finished walls and above new ceilings whether specifically mentioned or not.
- F. Provide sprinkler heads above and below all suspended ceiling areas having wood combustible construction.
- G. Provide sprinkler heads above all floating ceilings having Non-Combustible construction in accordance with NFPA and governing codes requirement.
- H. All exposed upright sprinkler heads in occupied spaces shall be chrome finish.
- I. Provide escutcheons on all sidewall sprinklers penetrating exposed walls.
- J. Provide sprinkler heads with wireguards below all exposed ductwork and suspended equipment that are 4 feet and wider.
- K. Provide wireguards on all exposed sprinkler heads located below 7'-0".
- L. All exterior sprinkler heads used in exposed areas shall be corrosion resistance type.
- M. Final count of all sprinklers shall be the responsibility of the fire protection contractor.

- N. All sprinkler style and color selections shall be by the architect.
- O. Prior to commencing work and disconnecting any fire protection piping for the renovation work, to ensure operational integrity of the existing fire protection system and where a required fire alarm system will be out of service for more than 4 hours in a 24-hour period, the authority having jurisdiction shall be notified and the building shall be evacuated, or an approved fire watch shall be provided for all parties left unprotected by the shut down until the fire alarm system has been returned to service.
- P. Once the proper fire watch has been established, disconnect the fire protection piping in the renovation area and drain the piping. Provide the new fire protection system per contract documents and connect to the existing system. Once the system is connected and before the system is filled with water, perform hydrostatic test for the entire fire protection system in the renovation area in accordance with NFPA-13, NFPA-25 and authorities having jurisdiction. Once all tests have been satisfied energize the system with water.
- Q. Any fire protection system piping, fittings, valves and any associated appurtenances when demolished and removed shall not be reused for the new renovation work under any circumstances.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 SYSTEM DESIGN

- A. The quantity of sprinklers shown on the drawing represents the minimum number of sprinklers required. Some revisions to the sprinkler as shown on fire protection drawings may be required as a result of coordination. Sprinkler type / style shall be provided in accordance with specifications.
- B. The sprinkler layout shall be centered in ceiling tiles / within 6" of center of tile. Minimum distance from vertical surface to centerline of sprinkler head: 12". Any deviation from this layout must be approved by the AHJ and the Architect.
- C. Coordinate the location of sprinklers and piping to ensure the adequate space is available. Provide additional sprinklers as required to meet NFPA 13 for adverse conditions, beam and bulkhead conditions, below large ducts, etc. at no additional cost to the owner.

- D. The entire fire protection system shall be hydraulically calculated and designed, sealed, and signed by a Licensed Registered Fire Protection Engineer and in accordance with NFPA. The hydraulic calculations shall use the results of a water supply flow / pressure test conducted by the Fire Protection Contractor. The water flow test data shall be no longer than one year old and acceptable to the AHJ.
 - 1. The fire protection system design and hydraulic calculations shall be submitted to the Owner Insurance Carrier, Fire Code Officials, Fire Department, and other Authorities Having Jurisdiction for review and sign-off.
 - 2. The signed-off fire protection system design and hydraulic calculations shall be submitted to the Architect / Engineer as a record submittal.
 - 3. for Healthcare Facilities; Submit three (3) copies of shop drawings and hydraulic calculations to the Department of Health, Division of Life Safety, for approval. Department of Health approved hydraulic calculations and drawings shall be on site prior to final Department of Health inspection.
- E. A minimum of 10 PSI cushion shall be provided between the water supply curve and the system design point. The Fire Protection Contractors base bid shall be for a fully operational sprinklered building.
- F. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
- G. Design shall be based on the occupancy hazards as specified Factory Mutual-FM Global.
- H. Minimum design requirements are listed below. Final design criteria shall be determined by the Fire Protection Contractor who will hydraulically calculate, design, seal and sign the design documents by a Licensed Registered Fire Protection Engineer.
- I. Design criteria based on FM - Factory Mutual Requirements for Wet Systems:
 - 1. Light Hazard Occupancy – HC-1:
Areas shall be designed for 0.10 GPM/SF over the most hydraulically remote 1,500 SF of floor area, with 250 GPM hose allowance and 60-minute duration. 225 Sq.Ft./Head, 5.6 K-Factor, Standard Response, 155 Deg. 1/2" Orifice.
 - 2. Ordinary Hazard Occupancy – HC-2:
Areas shall be designed for 0.20 GPM/SF over the most hydraulically remote 2,500 SF of floor area, with 250 GPM hose allowance and 60-minute duration. 130 Sq.Ft./Head, 8.0 K-Factor, Standard Response, 212 Deg. 17/32" Orifice.
 - 3. Extra Hazard Occupancy – HC-3:
Areas shall be designed for 0.30 GPM/SF over the most hydraulically remote 2,500 SF of floor area, with 500 GPM hose allowance and 90-minute duration. 100 Sq.Ft./Head, 11.2 K-Factor, High Temperature Response, 282 Deg. 5/8" Orifice.

- J. Where applicable, Provide upright sprinklers in all interstitial spaces. Where cat-walks are provided in interstitial spaces, provide sprinklers above the cat-walk.

2.2 SPRINKLERS

A. General

1. Standard response sprinklers shall be provided throughout the facility and in the following locations:
 - a. Autoclave areas
 - b. Electrical switchgear rooms
 - c. Transformer rooms
 - d. Electrical closets
 - e. Freezers Cold rooms
 - f. Mechanical rooms
2. response sprinklers shall be standard or high pressure type rated for 175 PSI
3. Sprinkler temperature ratings throughout the facility shall be ordinary classification in the following locations:
 - a. Autoclave areas
 - b. Electrical switchgear
 - c. Transformer rooms
 - d. Electrical closets
 - e. Mechanical rooms
 - f. Other areas in which high temperatures are experienced. For systems with high pressure, all sprinklers shall be high pressure type rated for 250 PSI.
4. Sprinklers shall be provided at least 12 inches from any air distribution devices. Sprinkler locations at wall mounted and peninsular shelving units shall be a minimum of 18 inches away.
5. Provide two (2) sprinkler head wrenches for each type of sprinkler head.
 - a. Wrenches shall be provided by the Fire Protection Contractor / sprinkler manufacturer that directly engage the hex-shaped wrench boss integrally cast in the sprinkler body. Victaulic FireLock Series.
6. Sprinklers shall be supplied from one (1) manufacturer.
7. Sprinklers using rubber O-rings or rubber seals are not permitted.
7. Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

B. Sprinkler Cabinet

1. Provide sprinkler cabinet with 12 spare sprinklers for each type of sprinkler provided for the project. Mount in the location as directed by the Owner.
 - a. Manufacturer and Model
 - 1) Viking – Model number 01742A Series
 - 2) Victaulic - Model number SA 000 0000.
 - 3) Tyco- Spare Sprinkler Cabinets
- C. Unless otherwise notes, the following type of sprinkles are used on the project:
 1. Exposed Sprinklers Upright or Pendant
 2. Concealed Sprinklers
- D. In all areas within Operating Rooms, Cath Lab, Ep-Lab, Pharmacy Rooms, and similar areas whether specifically mentioned or not shall be provided with concealed gasketed type sprinkler heads.
- E. In MRI rooms sprinkler shall be provided with suitable materials such as non-ferrous specifically designed for MRI suite.
- F. For Sprinkler Head Schedule refer to contract documents.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide the entire sprinkler design and system in accordance with NFPA 13: Standard for the Installation of Sprinkler Systems, Owner Insurance Carrier or as required by Factory Mutual-FM Global.
- B. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.
- C. Fire Protection Contractor shall notify the Owner Insurance Carrier, Fire Code Officials, Fire Department, and other Authorities Having Jurisdiction when fire protection installation is complete to schedule a final inspection by their personnel.

END OF SECTION 210700

SECTION 211000 – FIRE PROTECTION PIPING SYSTEMS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Fire Protection Systems used on this project shall be in accordance with Owner's Fire Protection Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner prior to final product purchase and installation.
- C. Unless required by the Local Authorities Having Jurisdictions and where the building is classified and categorized by the Structural Engineer as Seismic Design Category, all Systems shall be designed with seismic bracing. Where systems cross Building Expansion Joints, piping shall cross with appropriate expansion connections and shall be supported with appropriate bracing as described in related sections of the specifications.
- D. These specifications include information, descriptions and products that may not be specific to this project. It is intended to serve as a general Information related to the discipline.
- E. All components shall be UL listed and FM approved.

1.2 PIPING SYSTEM STANDARDS OF MATERIALS

- A. Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- B. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.

1.3 SYSTEM DESIGN

- A. Cross mains and branch lines shall be held as high above the floor lines as possible.
- B. Provide piping as required for complete drainage of the sprinkler systems.
- C. Branch lines, cross mains, and feed mains shall be graded towards the drainage point.
 - 1. Provide drain valves at low points.
 - 2. Where special conditions occur in branch lines, valved drainage pipes shall be provided with discharge piped to outside the building.
- D. Test pipes with ball valves and sight glasses shall be provided as required in the sprinkler systems.
- E. Provide approved flushing connections at ends of mains and cross mains as required by code.

1.4 SUMMARY

- A. This Section includes the following:

1. Piping and fittings.
2. Sprinkler specialty pipe fittings

B. Related Sections:

1. Section 210519 "Fire Protection Specialties" for fire department connections, roof manifolds, floor control valve assemblies and fire department hose valves.
2. Section 211316 "Dry-Pipe Sprinkler Systems" for dry-pipe sprinkler piping.
3. Section 213113 "Electric-Drive, Centrifugal Fire Pumps" for fire pumps, pressure-maintenance pumps, and fire-pump controllers.

1.5 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum. Where pressure in the system exceeds 175 psi provide 300 psi flanged fittings and Pressure Regulating Valves-PRV.

1.6 CODES AND REGULATIONS

- A. All requirements of the Facilities Management, and Occupational Safety and Health shall apply to this specification and design requirements, including the latest edition (unless otherwise specified) of the following codes and regulations:
1. International Building Code.
 2. Underwriters Laboratories Fire Protection Equipment List.
 3. Installation of Sprinkler Systems-NFPA 13.
 4. Code for Life Safety in Buildings and Structures-NFPA 101.
 5. Building Facilities Engineering Design Standards.

1.7 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
- B. Sprinkler System distribution shall be within a zone that matches smoke compartment zone separation defined by the Architect. Coordinate with the Architect and the Owner if this cannot be accomplished.
- C. Sprinkler coverage shall be maintained during the entire construction duration. Provide NFPA required Fire Watch for the removal of existing sprinkler system. Fire Protection Contractor shall coordinate with the Owner for coordinating the Fire Watch requirements.
- D. Where piping crosses over into an adjacent building that is installed with building expansion joint, all piping crossing the two building separations shall be installed with stainless steel flexible hose connection and/or 3-Way Swing Joint or 3-Dimensional 'U' Joint as approved by AHJ.

1.8 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

- B. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.
- C. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- D. For fire-hydrant flow test results refer to contract documents – Water Flow Test Data.

1.9 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Submit drawings, diagrams, hydraulic and flow calculations data, samples and manufacturers catalogue cuts at one time only and as a complete set. All drawings, diagrams, calculations and manufacturers data must be reviewed and approved by the City Fire Marshall and the Engineer before installation can take place. Partial Submittals will be rejected.
- C. Shop Drawings: For Wet-Pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- D. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Revise subparagraphs below to suit Project.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
 - 4. HVAC hydronic piping.
 - 5. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
- F. Qualification Data: For qualified Installer and professional engineer.
- G. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- H. Welding certificates.
- I. Fire-pump flow test report.
- J. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- K. Field quality-control reports.

- L. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.10 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.11 QUALITY ASSURANCE

- A. Installer Qualifications:

1. Engineering Responsibility: Design and preparation of working plans, shop drawings, calculations, field test reports, pipe support systems and trapeze by a qualified professional engineer.
2. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of piping, hangers and supports that are similar to those indicated for this project in material, design and extent.
3. Installer's responsibilities include designing, fabricating and installing fire protection systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of flow test.
 - a. The contract drawings show the intent of the design and shall be used to establish the Basis of Design. The contract drawings shall not be used as the basis for final installation and construction of the Fire Protection System.
 - b. The Fire Protection Contractor shall assume all responsibilities in providing a design and installation of the Fire Protection System in full compliance with NFPA-13, NFPA 14 and NFPA 20 and any required governing codes and regulations including but not limited to the requirements of the Local Authority having Jurisdiction.
 - c. The Fire Protection System Contractor shall assume all responsibilities for coordinating with all other trades and disciplines for a fully functional, operational, code compliant and approved system.
 - d. The project shall be 100% fully sprinklered with respect to all governing codes and regulations. Where there are any areas that sprinkler heads and piping are not indicated on the drawings, the Fire Protection Contractor shall notify the discrepancy in writing to the attention of the Engineer for a clarification and provide budget for the discrepancy prior to submitting the bid.
 - e. Where there are discrepancies in sizes or quantities between the plans the riser diagrams and actual field conditions, the contractor shall notify the discrepancy in writing to the attention of the Engineer for a clarification. For pricing purposes the contractor shall make allowance for the more stringent of the sizes and quantities in the budget.

- f. The locations of the existing services are believed to be as indicated on the drawings. The contractor shall verify the actual location of these services and notify the Engineer of any discrepancies prior to commencing any work.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1) NFPA 13, "Installation of Sprinkler Systems."
 - 2) NFPA 14, "Installation of Standpipes and Hose Systems."
 - 3) NFPA 20, "Installation of Stationary pumps for fire protection".

1.12 PROJECT CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sprinkler service.
 - 2. Do not proceed with interruption of sprinkler service without Construction Manager's written permission.

1.13 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Specifications are of simplified form and include incomplete sentences. Words or phrases such as "the contractor shall," "shall be," "furnish," "provide," "a," "the," and "all" have been omitted for brevity.
- C. Coordinate all new fire protection work with all existing and/or new ductwork, piping and utilities of any systems. Drawings are diagrammatic and show the intent of the design. Reroute any piping around existing and/or new systems including all required fittings and supports to make the installation of the piping and sprinkler heads possible. Reseal any fire and/or smoke rated penetrations that have been affected as a result of the modification.
- D. Remove, relocate and reconnect any existing piping that shall remain active in service which interferes with the new architectural layout, ceiling devices, equipment, new ceiling heights and any unforeseen condition arising from the new modifications. All existing and new piping shall be located concealed behind new finished walls and above new ceilings whether specifically mentioned or not.

- E. Prior to commencing work and disconnecting any fire protection piping for the renovation work, to ensure operational integrity of the existing fire protection system and where a required fire alarm system will be out of service for more than 4 hours in a 24-hour period, the authority having jurisdiction shall be notified and the building shall be evacuated, or an approved fire watch shall be provided for all parties left unprotected by the shut down until the fire alarm system has been returned to service.
- F. Once the proper fire watch has been established, disconnect the fire protection piping in the renovation area and drain the piping. Provide the new fire protection system per contract documents and connect to the existing system. Once the system is connected and before the system is filled with water, perform hydrostatic test for the entire fire protection system in the renovation area in accordance with nfpa-13, nfpa-25 and authorities having jurisdiction. Once all tests have been satisfied energize the system with water.
- G. Any fire protection system piping, fittings, valves and any associated appurtenances when demolished and removed shall not be reused for the new renovation work under any circumstances.

1.14 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
- B. Fire protection / sprinkler piping material shall be capable of withstanding a working pressure of not less than 175 PSIG.
- C. Fire protection system shall be constructed of the following materials, subject to approval by authorities having jurisdiction.
- D. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- E. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - 1. Allied Tube & Conduit Corporation.
 - 2. American Steel Pipe
 - 3. United States Steel Corporation.
 - 4. Wheatland Tube

2.2 WET-PIPE SPRINKLER PIPING SYSTEM:

- A. For pipe sizes 1" to 2" shall be standard weight schedule 40 black steel pipe, seamless and welded conforming to ASTM A 53/A 53M, type E, grade B. Pipe ends may be factory or field formed to match joining method. Joints shall be threaded.
- B. For pipe sizes $\geq 2\text{-}1/2$ " shall be light weight schedule 10 black steel pipe, seamless and welded conforming to ASTM A 135 or ASTM A 795/A 795 M, type E. Pipe ends may be factory or field formed to match joining method. Joints may be Roll-Grooved.

C. FITTINGS AND JOINTS:

- 1. Malleable or Ductile-Iron Unions: UL 860. Malleable cast iron threaded fittings.
- 2. Cast-Iron Flanges: ASME 16.1, Class 125.
- 3. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- 4. Steel Welded Fittings: ASTM A 234/A 234M and ASME B16.9
- 5. Pipe and fittings joined with grooved couplings shall be joined by a listed combination of couplings, gaskets, and grooved dimensions.
- 6. Grooved connections of fittings and valves, and grooves cut or rolled on pipe shall be dimensionally compatible with the coupling.
 - a. Permitted for pipe sizes 2 inch and larger.
- 7. Grooved-Joint, Steel-Pipe Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International, Inc.
 - 2) ITT Grinnell
 - 3) National Fittings, Inc.
 - 4) Shurjoint Piping Products.
 - 5) Tyco Fire & Building Products LP.
 - 6) Victaulic Company.
 - b. Pressure Rating: 175 psig minimum.
 - c. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- 8. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175 psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International, Inc.
 - 2) ITT Grinnell
 - 3) National Fittings, Inc.
 - 4) Shurjoint Piping Products.

- 5) Tyco Fire & Building Products LP.
- 6) Victaulic Company.

2.3 DRY-PIPE SPRINKLER PIPING SYSTEM:

- A. For pipe sizes 1" to 2" shall be standard weight schedule 40 galvanized black steel pipe, seamless and welded conforming to ASTM A 53/A 53M, type E, grade B. Pipe ends may be factory or field formed to match joining method. Joints shall be threaded.
- B. For pipe sizes $\geq 2\text{-}1/2$ " shall be light weight schedule 10 galvanized black steel pipe, seamless and welded conforming to ASTM A 135 or ASTM A 795/A 795 M, type E. Pipe ends may be factory or field formed to match joining method.
- C. All fittings in dry systems shall be provided with galvanized steel fittings and joints.
- D. For field threads and pipe work apply exposed surfaces with zinc coating.

E. FITTINGS AND JOINTS:

- 1. Malleable or Ductile-Iron Unions: UL 860. Malleable cast iron threaded fittings.
- 2. Cast-Iron Flanges: ASME 16.1, Class 125.
- 3. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- 4. Steel Welded Fittings: ASTM A 234/A 234M and ASME B16.9
- 5. Pipe and fittings joined with grooved couplings shall be joined by a listed combination of couplings, gaskets, and grooved dimensions.
- 6. Grooved connections of fittings and valves, and grooves cut or rolled on pipe shall be dimensionally compatible with the coupling.
 - a. Permitted for pipe sizes 2 inch and larger.
- 7. Grooved-Joint, Steel-Pipe Appurtenances:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International, Inc.
 - 2) ITT Grinnell
 - 3) National Fittings, Inc.
 - 4) Shurjoint Piping Products.
 - 5) Tyco Fire & Building Products LP.
 - 6) Victaulic Company.
 - b. Pressure Rating: 175 psig minimum.
 - c. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- 8. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175 psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) Anvil International, Inc.
- 2) ITT Grinnell
- 3) National Fittings, Inc.
- 4) Shurjoint Piping Products.
- 5) Tyco Fire & Building Products LP.
- 6) Victaulic Company.

2.4 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

- 1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
- 2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.

- a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

- 1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.

- a. Gaskets: AWWA C111, rubber.

- 2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.

- a. Gaskets: AWWA C111, rubber.

2.5 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

- E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

- F. Grooved-Joint, Copper-Tube Appurtenances:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Anvil International, Inc.
- b. Shurjoint Piping Products.

- c. Victaulic Company.
 - 2. Grooved-End, Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.
 - 3. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.
- G. Copper-Tube, Extruded-Tee Connections:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Shurjoint Piping Products.
 - c. Victaulic Company.

2.6 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, (1/8 inch thick).
- 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.7 COVER SYSTEM FOR SPRINKLER PIPING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. DecoShield Systems, Inc.
- B. Description: System of support brackets and covers made to protect sprinkler piping.
- C. Brackets: Glass-reinforced nylon.

2.8 HIGH PRESSURE PIPING SYSTEM

- A. High-pressure system piping regardless of size shall be schedule-40 black steel electric resistance weld pipe, ASTM A53 Grade-B & API-5L Grade-B PSL-1. Fittings shall be high pressure rated using Victaulic HP-70 coupling rated for 600 PSI to 750 PSI. All high-pressure components shall be 'UL' Listed and 'FM' Approved.

2.9 FLEXIBLE PIPING

- A. Flexible sprinkler drop connections are permitted by code Standards. Confirm with Owners Insurance Carrier, and AHJ of acceptance.
 - 1. Flexible sprinkler drop connections shall be FM approved, UL Listed for up to 300 PSI working pressure, shall be certified for the application for which it is being installed, and are limited to a maximum of six feet in length.
 - 2. Materials shall be flexible stainless steel, fully welded non-mechanical fittings, braided, leak tested with minimum of one inch true-bore internal corrugated hose diameter of 304 stainless steel.
 - 3. Ceiling brackets shall be direct attachment type provided with integrated snap-on clip ends positively attached to the ceiling using tamper-resistant screws and removable attachment hub with set screws for attaching and adjusting flexible hose.
 - 4. Manufacturer
 - a. FlexHead Industries
 - b. Viking Corp.
 - c. Victaulic Co.
- D. Outlet tee fittings similar to and including Victaulic 920 and shop welded outlets are permitted provided they are listed and approved and are compatible with the system pressure rating.

2.10 CPVC PIPING

- A. Use of CPVC fire sprinkler is limited to the following: Light Hazard Occupancy Only and shall be confirmed by the Owner's Insurance Underwriter and with local AHJ prior to including in project.
 - 1. Locations:
 - a. Light Hazard Occupancies as defined by NFPA 13.
 - b. Ordinary hazard rooms of otherwise light hazard occupancies where the room does not exceed 400 sq ft.
 - c. Residential Occupancies up to four stories in height as defined by NFPA 13R.
 - d. Air handling (plenum) spaces as defined by NFPA 90A.
 - e. Wet sprinkler systems where the maximum design temperature/pressure rating do not exceed 175 psi at 150°F.
 - 2. Materials:
 - a. The piping systems (pipe and fittings) shall be constructed from materials extruded/molded by manufacturers using the same compound manufacturer.
 - b. Pipe shall meet or exceed the requirements of ASTM F442 in standard dimension ratio (SDR) 13.5.
 - c. Fittings shall meet or exceed the requirements of ASTM F437 (schedule 80 threaded), ASTM F438 (schedule 40 socket) and ASTM F439 (schedule 80 socket).
 - 3. Installation:

- a. Installation practices such as pipe support spacing, bracing, allowance for thermal expansion/contraction, solvent cementing and handling and storage shall be in accordance with the manufacturer's instructions and the UL Listing which includes installation limitations.
 - b. Contractor shall have successfully completed formal CPVC fire sprinkler systems training conducted by an authorized CPVC manufacturer's representative. Fire Sprinkler Contractor must submit to the Contracting Officer documentation that lists personnel assigned to this project prior to beginning construction. Personnel's training certificates must be current and have been updated within the past two (2) years.
 - c. Follow manufacturer's instructions for set and cure times for solvent cement joints. Avoid significant stresses during set and cure times. Do not apply any stress that will disturb an un-dried joint. Sprinkler fittings shall be allowed to cure in accordance with the manufacturer's guidelines and the contractor shall assure the outlets are clear of any excess cement prior to installing sprinklers.
 - d. After the system is installed and any solvent cement is cured per the manufacturer's installation instructions, the systems shall be hydrostatically tested per the requirements of the applicable NFPA Standard NFPA 13.
4. Manufacturers:
- a. Blazemaster
 - b. Tyco
 - c. Viking
 - d. Victaulic
 - e. Nibco

PART 3 - EXECUTION

3.1 GENERAL

- A. Install entire sprinkler system in strict accordance with NFPA 13: Standard for the Installation of Sprinkler Systems.
- B. Test the system for two hours at 50 PSI over the system working pressure or 200 PSI whichever is greater. Record test data and submit for review and approval. Contractor shall make repairs and re-test as needed until system passes.
- C. The minimum slope towards the main drain of the system branch lines shall be 1/8"/ft. The minimum slope toward the main drain of the system mains shall be 1/16"/ft.
- D. With the exception of low point and auxiliary drains, all new system drains shall be hard piped to an approved exterior location, or to a safe location inside the building that shall accept full flow without causing property damage or a safety hazard.
- E. Auxiliary Drains
 - 1. Where piping is installed around obstacles such as a beam with a "U" shape bend where a trap is created, an auxiliary drain with a valve shall be provided where a change in piping direction prevents drainage of system piping through the main drain valve.

2. Provide an auxiliary drain for each location where piping pitch prevents complete drainage through the main drain valve. If the capacity of the trapped section exceeds 5 gallons, a valve must be provided and the outlet piped to a drain or convenient location acceptable to the AHJ.

G. Underground Pipe Flushing and Testing

3. Underground pipe shall be thoroughly flushed before connecting to the sprinkler system. Perform hydrostatic pressure test in accordance with NFPA 24.

3.2 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.3 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping. Comply with the requirements for backflow preventers in Section 211100 "Facility Fire protection Water-Service Piping."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.4 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.5 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Retain first paragraph below if piping is required to withstand seismic design loads.

- D. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- E. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- F. Install sprinkler piping concealed above ceiling and/or within walls.
- G. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- H. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- I. Where sprinkler piping is connected to standpipes or fire mains the connection shall be provided with floor Sprinkler System Zone Control Valve Assembly. The assembly shall include the following devices in the following order:
 - 1. Indicating-type floor control valve with supervisory tamper switch
 - 2. Check Valve
 - 3. Pressure Gauge
 - 4. Supervisory Waterflow Switch
 - 5. Inspector's test and drain assembly connection
 - 6. Inspector's test and drain assembly connection shall be provided with valve, sight glass, union and bypass valve.
- J. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- K. Install sprinkler piping with drains for complete system drainage.
- L. Drain risers shall be with the following:
 - 1. For standpipes 4" and greater drain riser shall be 2".
 - 2. For standpipes and floor sprinkler system zone control valve assemblies equipped with Pressure-Regulating Valves (PRV), drain riser shall be 3".
 - 3. All materials used for drain risers shall be galvanized steel with galvanized fittings.
- M. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- N. Install alarm devices in piping systems.
- O. See Editing Instruction No. 3 in the Evaluations for cautions about pipe hangers.
- P. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

- Q. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- R. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices and air compressors.
- S. Fill sprinkler system piping with water.
- T. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire Protection Piping" and for piping insulation in Section 220700.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210529 "Sleeves and Sleeve Seals for Fire protection Piping."
- V. Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210529 "Sleeves and Sleeve Seals for Fire protection Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210519 "Fire Protection Specialties."

3.6 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- N. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- O. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- P. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
- Q. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- R. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.7 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

- A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

3.8 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
 - 3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.9 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.10 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Fire protection system piping shall be tested hydrostatically at a pressure of 200 psi for duration of two hours without a loss in pressure. Repeat tests until system passes all tests.
- B. Tests and Inspections:
 - a. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - c. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - d. Energize circuits to electrical equipment and devices.
 - e. Coordinate with fire-alarm tests. Operate as required.
 - f. Coordinate with fire-pump tests. Operate as required.
 - g. Verify that equipment hose threads are same as local fire-department equipment.

- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare and submit test and inspection reports.

3.12 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.14 PIPING SCHEDULE

- A. As specified in piping materials.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.

3.15 SPRINKLER SCHEDULE

- A. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 - 3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 - 4. Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes

3.16 COMMISSIONING

- A. Verify that sprinklers, specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- B. Verify that specified tests of piping are complete.
- C. Verify that hose connections and fire department connections have threads compatible with local fire department equipment.
- D. Drain dry-type piping.
- E. Verify that hose connections are correct type and size.
- F. Verify that hose stations are correct type and size.
- G. Coordinate with fire alarm tests. Operate as required.

3.17 CONTRACTOR'S INSPECTION OF SYSTEM

- A. The Contractor shall thoroughly inspect the completed system to assure compliance with this document, project plans, NFPA 25, and all applicable Codes and Standards. IMPORTANT: This must include a test of each waterflow alarm switch and all system supervisory devices, in coordination with the fire alarm system Contractor.

END OF SECTION 211000

SECTION 220000 - PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Plumbing Systems used on this project shall be in accordance with Owner's and where applicable Tenant's Plumbing Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner and the Tenant prior to final product purchase and installation.

1.2 DEFINITIONS

- A. Specific terminology, as used herein, shall have the following meanings:
 - 1. "Provide"...Furnish and install, complete and ready for intended use.
 - 2. "Furnish"...Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar subsequent requirements.
 - 3. "Install"...Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
 - 4. "Concealed, Interior"...Concealed from view and protected from physical contact by building occupants.
 - 5. "Concealed, Exterior" ...Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures.
 - 6. "Exposed, Interior"...Exposed to view indoors (not concealed).
 - 7. "Exposed, Exterior"...Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
 - 8. "Finished Space" ...Space other than mechanical rooms, electrical rooms, furred spaces, pipe chases, unheated spaces immediately below roof, space above ceilings, unexcavated spaces, crawl spaces, tunnels, and interstitial spaces.
 - 9. "Conditioned"...Spaces directly provided with heating and cooling.
 - 10. "Unconditioned"...Spaces without heating or cooling including ceiling plenums.
 - 11. "Indoors"...Located inside the exterior walls and roof of the building.
 - 12. "Outdoors"...Located outside the exterior walls and roof of the building.
 - 13. "Atmosphere"...The same as outdoors.
 - 14. "Experienced" ...Skilled or Knowledgeable
 - 15. "Appurtenance" ...Any component required for complete installation and operation.
 - 16. The following are industry abbreviations for plastic materials:
 - a. ABS: Acrylonitrile-butadiene-styrene plastic.
 - b. CPVC: Chlorinated polyvinyl chloride plastic.
 - c. NP: Nylon plastic.
 - d. PE: Polyethylene plastic.
 - e. PVC: Polyvinyl chloride plastic.

- 17. The following are industry abbreviations for rubber materials:

- a. CR: Chlorosulfonated polyethylene synthetic rubber.
- b. EPDM: Ethylene propylene diene terpolymer rubber.

1.3 SUMMARY

THIS SECTION INCLUDES THE FOLLOWING:

1. Scope of Work.
2. Intent of Drawings.
3. Discrepancies in Documents
4. Pre-Bid Site Visit.
5. General Standards of Materials.
6. Products and Substitutions.
7. Temporary Shutdown of Existing Systems.
8. Coordination of Work.
9. Contractor's Responsibility for Evaluation.
10. Quality Assurance.
11. Codes, Standards, Licenses, Permits, Fees and Inspections.
12. Guarantees and Certificates.
13. Shop Drawings and Product Data.
14. Record Drawings.
15. Operation and Maintenance Manual.
16. As-Built Documents
17. Tools for Operation, Adjustment and Maintenance.
18. Start-Up
19. Access Doors and Panels
20. System Identification
21. Owner Instructions.

1.4 SCOPE OF WORK

- A. The scope of the work included under Division 22 of the specifications shall include complete systems as shown in the Contract Documents and Specifications as specified herein. Any work reasonably inferable or required to result in a complete installation or the intended operation and performance of the systems, shall be included in the Base Bid except where there is specific reference to exclusion and incorporation in other quotations.
- B. Plumbing Contractor shall examine all construction documents during the bidding phase to ensure plumbing installation can be provided without major modifications to any portion of the building as indicated on the construction documents.
- C. Contractor shall be responsible for quantities of equipment, materials and all associated appurtenances used on the project.
- D. Provide materials and installation procedures in conformance to all governing codes and the requirements of local authorities having jurisdiction.

1.5 INTENT OF DRAWINGS:

- A. Provide complete and functional systems for the project. The systems shall conform to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform to accepted trade practices. The drawings and specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this contractor's work.
- B. Do not scale the drawings. Due to the scale of the drawings, it is not possible to indicate offsets, fittings, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Coordinate and provide plumbing systems in a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items, components, and appurtenances required to meet the project conditions.
- C. Provide complete and functional systems for the project as required by architectural and engineering demolition and new construction design intent. Contractor expected to cross reference architectural, engineering, as-built, demolition and new construction documents and highlight discrepancies at bid.
- D. These documents may not explicitly disclose final details required for a complete systems installation however, contractors shall have the expertise to coordinate, evaluate, and provide necessary appurtenances for complete operating plumbing systems.
- E. Plumbing Contractor shall be "Experienced" in this type of construction and realize the extent of the work required.
- F. Where a product model number is indicated on the drawings or specifications and that product model is obsolete or no longer available, the bid price shall include currently available product model from specified manufacture with the same quality, capacity and warranty as the obsolete model listed.

1.6 DISCREPANCIES IN DOCUMENTS

- A. If drawings or specifications conflict or are unclear, the Plumbing Contractor shall advise Architect / Engineer in writing before award of contract. Otherwise, Architects / Engineers interpretation of contract documents shall be final.
- B. Where drawings or specifications do not coincide with manufacturers' requirements or with applicable codes and standards, the Plumbing Contractor shall advise Architect / Engineer in writing prior to award of contract. Otherwise, Plumbing Contractor shall provide revisions to their work as directed by Architect / Engineer within contract price.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specifications, the Plumbing Contractor shall provide material, installation, or work which is of the higher standard.

- D. The intent of the plumbing contract documents is for the Plumbing Contractor to provide plumbing systems and components that are complete and operational for the intended use. If the Plumbing Contractor discovers a discrepancy or requires a clarification and has failed to notify the Architect / Engineer of the situation in accordance with Paragraph (A) above, the Plumbing Contractor shall provide the specific systems or components within contract price.
- E. In cases covered by Paragraph (D) above, where the Plumbing Contractor believes direction or clarification is required from the Architect / Engineer, the Plumbing Contractor shall submit a sketch identifying the issued and a proposed solution. The Architect / Engineer will review proposed solution, note if necessary, and return.
- F. Where there are discrepancies in sizes or quantities between the plans and the riser diagrams, the contractor shall bring the discrepancy to the attention of the engineer for a clarification. For pricing purposes, the contractor shall make allowance for the more stringent of the size and quantity in the budget.
- G. Contractor shall be responsible to fully review and understand all contract documents (drawings and specifications) information to fully comply with the design intent. Contractor shall be responsible to notify the engineer of record in writing of any discrepancies in the contract documents or items not in compliance with the authorities having jurisdiction, codes and regulations prior to ordering any materials or commencing any work. All work installed by the contractor due to failure to provide notification shall be removed and replaced within contract price. Contractor shall further be responsible to prepare and submit for review and approval by the engineer of record shop drawings for all contract work complying with all Federal, State and Local Authorities' regulations and industry accepted engineering and construction standards and practices.

1.7 PRE-BID SITE VISIT

- A. Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions. To schedule a visit, contact the Owner and the Architect at least 48 hours in advance prior to desired date and time of visit.
- B. Failure to advise Architect / Engineer of potential issues and / or concerns in writing during Pre-Bid Site Visit assumes Plumbing Contractor accepts construction documents. No allowances will be made for difficulties encountered or any expense incurred because of existing conditions or items, which are visible or known to exist.

1.8 GENERAL STANDARDS OF EQUIPMENT AND MATERIALS

- A. Equipment and material shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five (5) years.
- B. Equipment and material of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts, piping, and components.

- C. Equipment and materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.
- D. With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.
- E. Furnish all materials and equipment new, free from defects and with listings or labels of Underwriter's Laboratories, Inc. or other nationally approved testing laboratory.
- F. All items of a given type shall be the product of the same manufacturer.
- G. All materials and equipment shall be the product of manufacturers regularly engaged in their manufacture.

1.9 PRODUCTS AND SUBSTITUTIONS

- A. Where several manufacturers' products are specified, the contract amount shall be based upon the specified manufacturer and model only. Any substitutions from the specified manufacturers and models shall be offered to the Architect / Engineer as a substitution request a minimum of ten (10) days prior to the bid date for review and approval. Plumbing substitutions will not be permitted or reviewed after the bidding phase without a substitution request included as part of the base bid.
- B. Where only one manufacturer's product is specified, the associated systems have been designed based on that product. Where several manufacturers' products are specified, the associated systems have been designed based on the first named manufacturer's product. When products other than those used as the basis of design are substituted, the Plumbing Contractor shall pay additional costs related to manufacturer and model submissions reviews, plumbing redesign, and modifications to design and / or installation required by the use of that product.
- C. It is the intent of these specifications that service organizations such as balancing agencies follow the above substitution procedures.

1.10 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

- A. Plan installation of plumbing systems and connections to existing plumbing systems to insure minimum interference with regular operation of existing plumbing systems. Some temporary shutdowns of existing plumbing systems may be required to complete the work.
- B. Submit to the Owner in writing for approval, proposed dates, time, and duration of temporary shutdowns of existing plumbing systems.
 - 1. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner.

2. Provide detailed written description of temporary shutdown requirements to Owner. The Owner reserves the right to require the Plumbing Contractor to provide a walk-through prior to any shutdown.
 3. To minimize conflict with Owner's operation, shutdowns shall be planned to occur on weekday between 12:00 a.m. and 6:00 a.m. or on weekends, as approved by the Owner.
 4. To ensure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections.
- C. Shutdowns shall be performed by the Owner. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors. No additional charges shall be allowed for Owner canceled shutdowns that must be rescheduled.

1.11 COORDINATION OF WORK

- A. Coordinate and furnish in writing to the Architect / Engineer information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.
- B. Installation of permanent plumbing systems shall not proceed until coordination drawings are submitted by the Plumbing Contractor to the Architect / Engineer for review and comment. No extra charges will be allowed for changes required to install plumbing system installation that occurred prior to review of the coordination drawing by the Architect / Engineer.
- C. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
- D. Coordinate exact location and final quantities of all plumbing fixtures with architectural dimensioned drawings.
- E. When work is installed without proper coordination, changes to this work deemed necessary by the Architect / Engineer shall be made to correct the conditions without extra cost to the Owner.
- F. The value of the coordination drawings shall be identified as a line item in the Schedule of Values. If the coordination drawings are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of coordination drawings shall be a minimum of two (2.0) percent of this Contract Amount.
- G. The plumbing drawings show the general arrangement of piping and appurtenances. Follow these drawings as closely as the actual construction will permit. Confirm the plumbing work to the requirements shown on the drawings. Provide offsets, fittings and accessories, which may be required but not shown on the drawings. Investigate the site, structural and finish ground conditions affecting the work and arrange the work accordingly. Provide such work and accessories as may be required to meet such conditions.
- H. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.
- I. Carefully check space requirements with other trades to ensure that all materials can be installed in the spaces allocated to include finished suspended ceilings.

- J. Transmit to other trades all information required for work to be provided under their sections in ample time for installation.
- K. Provide all sleeves for passage of pipes and conduits through walls and floors and elsewhere as required for the proper protection of each pipe passing through building surfaces.
- L. Provide required supports and hangers for piping and equipment, designed so as not to exceed allowable loadings of structures.
- M. Examine and compare the contract drawings and specifications with the drawings and specifications of other disciplines and report any discrepancies between them to the General Contractor. Obtain written instructions for changes necessary in the work of this Section. Install and coordinate the work of this section in cooperation with installing interrelated work. Before installation, take proper provisions to avoid interferences. All changes required in the work of the contractor, caused by his neglect to do so, shall be made by him at his own expense.
- N. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale the same size as contract drawings. With these layouts, coordinate the work with the work of the contractor. Such detailed work shall be clearly identified on the drawings as to the area where it applies. Submit these drawings to the Engineer for review. At completion, however, include a set of such drawings with each set of as-built drawings. When directed by the Engineer, submit drawings for review, clearly showing the work of this section and its relation to the work of other disciplines before commencing shop fabrication or erection in the field.
- O. Before commencing work, examine all adjoining work on which this work is in any way dependent for perfect workmanship and report any conditions, which prevent performance of first-class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.
- P. Provide required anchor bolts, sleeves, inserts and supports. Direct location of anchor bolts, sleeves, inserts and supports to ensure that they are properly installed. Any expense resulting from the improper location or installation of anchor bolts, sleeves, inserts and supports to be paid for by the contractor.
- Q. Slots, chases, openings and recesses through floors, walls, ceilings and roofs shall be provided by the various trades in their respective materials. Properly locate such openings and be responsible for any cutting and patching caused by the neglect to do so.
- R. Adjust location of pipes, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each pipe prior to fabrication.
 - 1. Right-of-Way: Pipes, which pitch have the right-of-way over those that do not pitch, i.e., plumbing drains. Pipes whose elevations cannot be changed have right-of-way over pipes whose elevations can be changed.
 - 2. Make offsets, transitions and changes in direction in pipes as required to maintain proper head room and pitch on sloping lines whether or not indicated on the drawings. Furnish and install all traps, air vents, drains, etc., as required to affect these offsets, transitions and changes in direction.

- S. Install all plumbing work to permit the removal (without damage to other parts) of equipment requiring periodic replacement or maintenance. Arrange pipes and equipment to permit access to valves, cocks, starters, motors, control components and to clear the openings of swinging doors and access panels.
- T. The contractor shall coordinate his work with the work of all other trades.

1.12 CONTRACTOR'S RESPONSIBILITY FOR EVALUATION

- A. The Engineer and Owner make no representations, regarding the character or extent of the existing structural, mechanical and electrical installations which may be encountered during the Work. The contractor must make his own evaluation of existing conditions, which may affect methods or cost of performing the Work, based on his own examination of the facility or other information. Failure to examine the drawings or other information shall not relieve the contractor of his responsibility for satisfactory accomplishment of the Work.
- B. The locations of existing services are believed to be as indicated on the plans. The contractor shall verify the location of these services prior to commencing any work and notify the Engineer of any discrepancies.

1.13 QUALITY ASSURANCE

- A. Materials furnished and work installed shall comply with applicable codes listed in Division 01 and with the requirements of governmental departments or authorities having jurisdiction.
- B. Wetted surfaces of every pipe, fixture, fitting, and applicable appurtenance used to convey water for potable use shall be provided in accordance with the Federal "Reduction of Lead-In Drinking Water Act" – 2011. Manufacturer model numbers indicated in the plumbing specifications are provided to establish quality of construction but may not reflect the lead-free version of that product. The Plumbing Contractor shall be responsible to provide the lead-free version of pipe, fixture, fitting, or applicable appurtenance from one of the specified manufacturers.

1.14 CODES, STANDARDS, LICENSES, PERMITS, FEES AND INSPECTIONS

- A. Materials furnished and work installed shall comply with the following codes:
 - 1. International Building Code - IBC
 - 2. International Plumbing Code – IPC
 - 3. International Energy Conservation Code - IECC
 - 4. National Fire Protection Association – NFPA
 - 5. All Authorities Having Jurisdiction
- B. Materials and equipment furnished for the electrical portion of the plumbing systems shall comply with the National Electrical Code and bear the approval label of or shall be listed by the Underwriters' Laboratories, Inc.
- C. Plumbing Contractor shall provide labor, materials, services, apparatus, drawings, and appurtenances required to comply with applicable laws, ordinances, rules and regulations, whether or not shown on the drawings and / or specified.
- D. Codes:

1. Comply with all adopted governing codes, ordinances and regulations, UL and all other applicable Federal, State and Local Codes.

E. Standards:

1. The standards listed in the Specifications can be obtained from the organizations listed as follows:
 - a. AIA American Insurance Association
 - b. ANSI American National Standard Institute, Inc.
 - c. ASA American Standards Association
 - d. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
 - e. ASME American Society of Mechanical Engineers
 - f. ASTM American Society for Testing and Materials
 - g. AWS American Welding Society
 - h. AWWA American Water Works Association
 - i. IEEE Institute of Electrical and Electronics Engineers
 - j. NEC National Electrical Code
 - k. NEMA National Electrical Manufacturers Association
 - l. OSHA Occupational Safety and Health Act
 - m. UL Underwriters Laboratories, Inc.
2. The particular specification will be identified by appropriate prefix and number only with the latest revision being applicable unless otherwise noted.

F. Licenses:

1. Plumbing contractor shall procure all licenses and approvals based on the local governing requirements prior to commencing any work.

G. Permits:

1. Comply with the requirements of the State adopted Building Code, and other agencies or authorities having jurisdiction over any part of the Work and secure all necessary permits to fully complete the project.
2. Where codes or standards are listed herein, the applicable portions apply.
3. Plans, specifications, codes and standards are all minimum requirements. Where requirements differ, apply the more stringent requirement.
4. Should any change in plans or specifications be required to comply with governing regulations, the contractor is to notify the Engineer at the pre-bid meeting.

H. Fees:

1. Plumbing contractor shall obtain and pay for all required permit fees associated with approval and installation of plumbing systems and associated appurtenances.
2. Pay royalties or fees required in connection with the use of patented devices and systems.

I. Inspections:

1. Allow time for work inspection during and after or as required by the inspecting authority.
2. Work shall continue to progress until final inspections are executed and approved by the inspecting authority.
3. Any additional work resulting from inspections shall be brought to the Architect/Engineer for review and direction.

1.15 GUARANTEES AND CERTIFICATES

- A. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated warrantee period.
1. Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of equipment, components, fixtures, testing, etc., prior to occupancy shall not be considered part of the warranty period.
- B. Prior to application for a "Certificate of Substantial Completion" of the plumbing systems, the Plumbing Contractor shall provide the following in writing:
1. Description of each installed plumbing system and confirmation that it is operational for its intended purpose.
 2. Confirmation that plumbing components, and appurtenances have been installed and electrical connections have been made.
 3. Confirmation start-up and test sheets have been completed and submitted to the Architect / Engineer for review.
 4. Confirmation that plumbing insulation has been provided in its entirety.
 5. Confirmation that access doors / panel are located to provide adequate access to plumbing components.
 6. Confirmation that pipe, valves and equipment identification clearly indicate plumbing system type.
 7. Confirmation plumbing system piping, equipment and components have been tested, cleaned and operational.
 8. Confirmation that equipment has been provided in accordance with manufacturer's requirements.
 9. Confirmation that tests, start-up procedures, and Owner training has occurred.
 10. Confirm all items indicated as part of Field Reports and Final Punch Lists have been completed and signed off.
 11. Final Operation and Procedure Manuals have been submitted and approved.

1.16 SHOP DRAWINGS AND PRODUCT DATA

- A. Shop Drawing and Product Data Submittal Procedures
1. Plumbing Contractor shall prepare and submit electronic submittals.
 - a. Submit electronic submittals (PDF) files to the Architect / Engineer and Commissioning Agency for review. The Owner may request paper copies of certain submittals for onsite coordination.

- b. Permits, Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Permits, Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
- 2. Product Data: Plumbing Contractor shall compile information into a single submittal for each component, piece of equipment, and appurtenances.
 - a. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 - b. Mark each copy of each submittal to show which products and options are applicable.
 - c. Include the following information:
 - 1) Submittal Package number and Submittal Item number.
 - 2) Manufacturer's catalog cuts.
 - 3) Manufacturer's product specifications.
 - 4) Statement of compliance with specified referenced standards.
 - 5) Testing by recognized testing agency.
 - 6) Application of testing agency labels and seals.
 - 7) Notation of coordination requirements.
 - 8) Availability and delivery time information.
 - d. For equipment, include the following in addition to the above, as applicable:
 - 1) Wiring diagrams showing factory-installed wiring.
 - 2) Printed performance curves
 - 3) Operational range diagrams.
 - 4) Clearances required to other construction, if not indicated on accompanying Shop Drawings.
- 3. Shop Drawings: Plumbing Contractor shall prepare project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 - a. Include the following information:
 - 1) Submittal Package number and Submittal Item number.
 - 2) Identification of products.
 - 3) Schedules.
 - 4) Compliance with specified standards.
 - 5) Notation of coordination requirements.
 - 6) Notation of dimensions established by field measurement.
 - 7) Relationship and attachment to adjoining construction clearly indicated.
 - 8) Seal and signature of professional engineer if required.
 - b. Sheet Size: Except for templates, patterns and similar full-size drawings, submit Shop Drawings on sheets no larger than 30 by 42-inches.

- c. Upon receipt of Revise and Resubmit or Rejected shop drawings, the Plumbing Contractor shall make all noted modifications then resubmit to the Architect / Engineer and Commissioning Agency within ten (10) days of receiving returned submittal.
 - 1) No plumbing work may proceed until shop drawings have been reviewed by Architect / Engineer and Commissioning Agency.
- B. Prior to submission of any shop drawing or product data to Architect / Engineer for review, the Plumbing Contractor shall:
 - 1. Review, stamp, date, and sign the submission confirming that the manufacturer, model number, construction criteria and appurtenances include in the shop drawing submittal are in compliance with the plumbing contract document requirements.
 - 2. Submit dated and signed submittal to the Construction Manager or General Contractor for confirmation that the shop drawing submission is in compliance with the plumbing contract documents.
 - 3. Confirm that the Construction Manager or General Contractor has forwarded the submittal to the Architect / Engineer for review.
 - 4. Submittals not provided with review confirmation, date and signature will be returned without review.
- C. The following shop drawings shall be submitted by the Plumbing Contractor for review:
 - 1. Welding certificates
 - 2. Access doors and panels
 - 3. Plumbing specialties (i.e. thermometers, pressure gauges, water hammer arrestors, trap primers, etc.)
 - 4. Valves
 - 5. Hangers, anchors, support and guides
 - 6. Equipment, pipe and valve Identification
 - 7. Piping
 - 8. Equipment
 - 9. Fixtures and trim
 - 10. Product data for system components and materials (including construction standards)
 - 11. Samples of finishes and trim exposed to view, such as cleanout plates, fixture trim, escutcheon plates and similar items
 - 12. Miscellaneous plumbing components
- D. The value of shop drawings, product data and samples shall be identified as a line item in the Schedule of Values. If the shop drawings, product data and samples are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of these items shall be a minimum of two (2.0) percent of this Contract Amount.
- E. SHOP DRAWING PREPARATION
 - 1. The Architect / Engineer will not review plumbing submittals that do not include the Plumbing Contractor's approval stamp and will return them without action.

- a. The Architect / Engineer will review each submittal, make marks to indicate corrections or modifications required and return to the Plumbing Contractor. The Architect / Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action. Actions and their requirements are as follows:
 - 1) REVIEWED: No correction or resubmissions required
 - 2) REVIEWED, AS NOTED: Contractor shall comply with noted corrections and comments but may proceed. If for any reason the Plumbing Contractor cannot comply with the noted corrections, the Contractor shall resubmit with an explanation of why the corrections cannot be made or implemented. The Architect / Engineer or Owner will review the explanation and determine if it is satisfactory or if another solution is required.
 - 3) REVISE AND RESUBMIT: Contractor shall review the comments, revise the submittal accordingly and resubmit. Plumbing work associated with submittal shall not proceed until all corrective actions are taken.
 - 4) NOT REVIEWED: Submittals not required by to be reviewed by the Architect / Engineer.
2. Incomplete submittals are not acceptable and will be returned without review.
3. Review of separate items or components that are not submitted as an assembly or system does not constitute review of the assembly or system in which the item functions.
4. Submit similar components in on one submission package. do not submit each item by item itself. For example:
 - a. Submit all plumbing fixtures together along with their trim and associated appurtenances.
 - b. Submit all valves together
 - c. Submit all backflow preventers, vacuum breakers, trap primers, water hammer arrestors, hose bibbs, non-freeze hose bibbs, etc. together.
5. On projects that have commissioning, the Commissioning Authority will receive copies of the submittals through the Design Professional and will provide comments on the submittals via the Design Professional.

F. Contractors Submittal Schedule

1. The Plumbing Contractor shall provide a shop drawing submittal schedule to the Architect / Engineer that indicates date for when all shop drawings, samples, material, and appurtenances will be submitted and date for when approval is required.

1.17 RECORD DRAWINGS

- A. The contractor shall maintain a complete set of "Record Drawings" reflecting an accurate dimensional record of all work. These drawings shall be marked up to show the precise location of concealed work and equipment, including concealed piping and valves and all changes and deviations in the plumbing work from that shown on the contract drawings. This requirement shall not be construed as authorization for the contractor to make changes in the layout or work without written definite instruction from the Architect or Engineer.

- B. Record dimensions shall clearly and accurately delineate the work as installed; location shall be suitably identified by at least two dimensions to permanent structures.
- C. The contractor shall stamp all "Record Drawings" and certify for correctness by signing and dating them.
- D. Record drawings submitted to Owner shall be in accordance with Owner's preference. Request direction from Owner for the type of medium such as reproducible drawings, pdf, AutoCad or Revit.
- E. Prior to final acceptance, contractor shall submit certified "Record Drawings" to the Architect/Engineer for review and make changes, corrections or additions as noted by Architect/Engineer. After this review, the drawing shall be delivered to the Owner.

1.18 OPERATION AND MAINTENANCE MANUAL

A. Requirements For Operation And Maintenance Manuals

- 1. Organize the manual into separate sections by CSI number based on the table of contents of the project manual, for each system and subsystem, and a separate section for each piece of equipment not part of a system. The manual shall contain the following materials, in the order listed:
 - a. Title page.
 - b. Table of contents.
 - c. Manual contents:
 - 1) Operation data.
 - 2) Product maintenance data
 - 3) Systems and equipment data
- 2. Title page shall include the following information:
 - a. Subject matter included in manual.
 - b. Name and address of Project.
 - c. Name and address of Owner.
 - d. Date of submittal.
 - e. Name and contact information for Plumbing Contractor.
 - f. Name and contact information for Construction Manager or General Contractor.
 - g. Name and contact information for Design Professional.
 - h. Name and contact information for Commissioning Agent.
 - i. Names and contact information for major consultants to the Design Professional that designed the systems contained in the manuals.
 - j. Cross-reference to related systems in other operation and maintenance manuals.
- 3. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

- a. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
 4. Manual Contents: Arrange contents alphabetically by system, subsystem, and equipment. Assemble instructions for subsystems, equipment, and components of one system into a single binder.
 5. Submit electronic (PDF) copy of the manual, to the Architect / Engineer for review.
- B. Operation Data
 1. Include operation data and the following information:
 - a. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - b. Operating standards.
 - c. Operating procedures.
 - d. Operating logs.
 - e. Wiring diagrams.
 - f. Control diagrams.
 - g. Piped system diagrams.
 - h. Precautions against improper use.
 - i. License requirements including inspection and renewal dates.
 2. Descriptions: Include the following:
 - a. Product name and model number. Use designations for products indicated on Contract Documents.
 - b. Manufacturer's name.
 - c. Equipment identification with serial number of each component.
 - d. Equipment function.
 - e. Operating characteristics.
 - f. Limiting conditions.
 - g. Performance curves.
 - h. Engineering data and tests.
 - i. Complete nomenclature and number of replacement parts.
 3. Operating Procedures: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Instructions on stopping.
 - f. Normal shutdown instructions.
 - g. Seasonal and weekend operating instructions.
 - h. Required sequences for electric or electronic systems.
 - i. Special operating instructions and procedures.
 4. Systems and Equipment Controls: Describe the sequence of operation and diagram controls as installed.

5. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

C. Product Maintenance Data

1. Organize data into a separate section, within the O & M Manual, for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
2. List each product included in section identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
3. Product Information: Include the following:
 - a. Product name and model number.
 - b. Manufacturer's name.
 - c. Color, pattern, and texture.
 - d. Material and chemical composition.
 - e. Reordering information for specially manufactured products.
4. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Schedule for routine cleaning and maintenance.
 - e. Repair instructions.
5. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
6. Warranties and Guarantees: Include copies of warranties and guarantees lists of circumstances and conditions that would affect validity of warranties.
7. Include procedures to follow and required notifications for warranty claims.

D. Systems And Equipment Maintenance Data

1. For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
2. List each system, subsystem, and piece of equipment included in a separate section within the Operation and Maintenance Manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
3. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

- a. Standard maintenance instructions and bulletins.
 - b. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - c. Identification and nomenclature of parts and components.
 - d. List of items recommended to be stocked as spare parts.
 4. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - a. Test and inspection instructions.
 - b. Troubleshooting guide.
 - c. Precautions against improper maintenance.
 - d. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - e. Aligning, adjusting, and checking instructions.
 - f. Demonstration and training video recording, if available.
 5. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - a. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - b. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
 6. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
 7. Warranties: Include copies of warranties and lists of circumstances and conditions that would affect validity of warranties.
 8. Include procedures to follow and required notifications for warranty claims.
- E. Prior to submission of any Operation and Maintenance Manual to Architect / Engineer for review, the Plumbing Contractor shall:
1. Review, stamp, date, and sign the submission confirming that the content of the Operation and Maintenance Manual submittal in compliance with the plumbing contract document requirements.
 2. Submit dated and signed submittal to the Construction Manager or General Contractor for confirmation that the Operation and Maintenance Manual is in compliance with the plumbing contract documents.
 3. Confirm that the Construction Manager or General Contractor has forwarded the submittal to the Architect / Engineer for review.
- F. Operation and Maintenance Documentation shall be provided for review.
1. Correct or modify the manual to comply with the Architect / Engineer and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect / Engineer and Commissioning Authority's comments and prior to commencing demonstration and training.

- G. Product Maintenance Data: Assemble a complete set of maintenance data, in a separate section, within the Operation and Maintenance Manual, indicating care and maintenance of each product, material, and finish incorporated into the Work.
- H. Operation and Maintenance Data: Assemble a complete set of operation and maintenance data, in a separate section, within the Operations and Maintenance Manual, indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate section within the Operation and Maintenance Manual, for each system and subsystem, in the form of an instructional manual for use by operating personnel.
- I. Manufacturers' Data: Where manual contain manufacturers' standard printed data; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - 1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in As-built Drawings to ensure correct illustration of completed installation.
- K. Do not use original project record documents as part of operation and maintenance manuals.

1.19 AS-BUILT DOCUMENTS

- A. As-Built Drawings:
 - 1. Maintain one set of marked-up paper copies of the plumbing contract drawings and shop drawings on-site.
 - 2. Plumbing Contractor shall mark As-built Drawings daily to indicate the actual installation where installation varies from that shown on the construction documents.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - 3. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Revisions to routing of piping.
 - d. Actual equipment locations.

- e. Locations of concealed internal plumbing systems.
 - f. Changes made by Change Order or Change Directive.
 - g. Changes made following the Owner's written orders.
 - h. Details not on the original Contract Drawings.
 - i. Field records for variable and concealed conditions.
 - j. Record information on the plumbing work that is shown only schematically.
 4. Mark As-Built sets with red-color. Use other colors to distinguish between changes for different categories of the plumbing work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. As-Built Specifications:
1. Mark As-Built specifications to indicate the actual product installation and installations that varied from that indicated in construction document specifications, addenda, and contract modifications.
 2. Plumbing Contractor shall mark As-built Specifications daily to indicate the actual manufacturer and model numbers and where items vary from that indicated in the construction specifications.
 - a. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - b. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 - c. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 - d. Note related Change Orders, record Product Data, and turnover Drawings where applicable.
- C. Prior to submission of any As-Built Drawing or As-Built Specification to Architect / Engineer for review, the Plumbing Contractor shall:
1. Review, stamp, date, and sign the submission confirming that the content of the As-Built submittals are in compliance with the plumbing contract document requirements.
 2. Submit dated and signed submittal to the Construction Manager or General Contractor for confirmation that the As-Built submittal is in compliance with the plumbing contract documents.
 3. Confirm that the Construction Manager or General Contractor has forwarded the submittal to the Architect / Engineer for review.
- D. Recording And Maintenance
1. Maintain and submit written change log to the Architect / Engineer, monthly for review indicating items incorporated in contract turnover documents concurrent with progress of the plumbing work, including modifications, concealed conditions, field changes, product selections, and other notations incorporated.

2. Maintain one copy of each submittal during the construction period for contract turnover document purposes. Post changes and modifications to contract turnover documents as they occur; do not wait until the end of the Project.
3. Store turnover documents in the field office apart from the Contract Documents used for construction. Contract turnover documents are not to be used for construction purposes. Maintain turnover documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to contract turnover documents for the Architects / Engineers reference performance of Contract.
4. Before Plumbing Contractor can request final payment, the project record drawings shall be submitted to the Architect / Engineer at the end of the project for review.

1.20 TOOLS FOR OPERATION, ADJUSTMENT AND MAINTENANCE

- A. Deliver to Owner's representative all special tools needed for proper operation, adjustment and maintenance of equipment.

1.21 START-UP

- A. Properly lubricate all pieces of equipment.
- B. Check and clean all pipes of dirt and debris, including strainers.
- C. Prepare each piece of equipment in accordance with manufacturer's installation instructions and have a copy at the equipment.
- D. Fill and vent all water systems.
- E. Check rotation on each motor.
- F. Have representatives of each manufacturer present when hereinafter specified, so that equipment will be started up by manufacturer.

1.22 ACCESS DOORS AND PANELS

- A. Furnish access doors as required for operation and maintenance of concealed equipment, clean-outs, valves, shock absorbers, trap primers, controls, etc., and coordinate their delivery with the installing trade.
- B. Coordinate and prepare a location, size and function schedule of access doors required and deliver to the General Contractor and the Architect for review.
- C. Doors shall be of a size required for operating and repacking valves, and shall be as manufactured by Karp Associates, Nystrom Inc., or Mifab.
- D. Unless otherwise indicated, minimum size shall be 18-inch x 18-inch or as directed by the Architect/Engineer where space may be limited.
- E. Furnish color coded buttons or tabs to indicate location of valves or other equipment located above removable type ceilings where access doors are not required.

- F. Access doors shall have a fire rating compatibility with the wall construction in which they are located. In areas with rated partitions the access doors / panels shall be constructed of fire-rated type.

1.23 SYSTEM IDENTIFICATION

A. Piping:

1. All piping, exposed or concealed shall be identified as to its service in accordance with OSHA and ANSI Standards by one of the following methods:
2. Piping identification markings shall be installed as follows:
 - a. In each room.
 - b. All valve locations.
 - c. At shaft walls.
 - d. Every 40 feet on continuous piping runs where piping is visible.
 - e. Where the ceiling space is limited piping shall be marked closer so as piping can be identified where any ceiling tile is removed for access.
 - f. On both sides of wall.
3. All pipe markings shall be provided with flow directional arrows.
4. Valves:
 - a. Valves shall be identified by a tag system utilizing brass tags at 2 inch minimum diameter and attached to the valves using brass chain.
 - 1) The new valve tag identification numbers shall be permanently added to all existing valve tag charts within the building.
 - b. Provide valved and capped piping for future use. Pipe caps shall be installed minimum 2'-0" away from end of valve.
5. Equipment:
 - a. Identify all controls such as motor starters not in motor control centers, float switches, and alarms.
 - b. Each piece of equipment shall be tagged with minimum 1" tall limacoid labels (white with black background) affixed permanently.

1.24 OWNER INSTRUCTIONS

- A. After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project.

- B. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Operate equipment for sufficient as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures.
- C. Minimum instruction period shall be broken into segments at the direction of the Owner. It is recommended 8 hours for this project
 - 1. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one (1) week prior to conducting same.
 - 2. Provide sign off sheet for every training session that includes:
 - a. Agenda
 - b. Date
 - c. Attendees
 - d. Training session subject
 - e. Training session presenter
 - f. List of questions and comments
 - 3. Plumbing Contractor and / or Manufacturers' Representative shall provide the above within five (5) days after each training session.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 220000

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Demolition of Plumbing Systems
 - 2. Installation of Plumbing Systems
 - 3. Cutting and Patching
 - 4. Waterproofing
 - 5. Air Plenums
 - 6. Electrical Connections and Protection
 - 7. Accessibility
 - 8. Painting
 - 9. Equipment Foundations, Supports, Piers and Attachments
 - 10. Cleaning, Protection and Adjustment
 - 11. Special Tools
 - 12. Soldering
 - 13. Welding
 - 14. Dielectric Fittings
 - 15. Sleeves
 - 16. Escutcheons
 - 17. Grout
 - 18. Site Water System Flow Test

1.3 DEMOLITION OF PLUMBING SYSTEMS

- A. Where applicable, review construction documents, to determine areas affected by demolition. Remove plumbing systems in the affected areas not to be reused including equipment, piping, hangers, supports, etc.
- B. Provide support / bracing as required for any existing plumbing system and equipment that is to remain but affected by demolition.
- C. Where existing plumbing systems serve areas adjacent to but not affected by demolition, reconnect existing plumbing systems serving unaffected areas to existing or new plumbing systems serving affected areas. test and certify all affected systems.
- D. Any plumbing system piping, fittings, valves and any associated appurtenances when demolished and removed shall not be reused for the new renovation work under any circumstances.
- E. All hot water and hot water return piping branches that are marked for removal shall be removed and reconnected back to an active line. Active piping shall have no capped piping from where the existing piping was removed such as a capped tee under any circumstance.

- F. If existing and/or new piping, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- G. Contractor shall be responsible to test for proper operation of all existing valves regardless of size and type that shall remain in the active renovation area. Valves that fail for proper functioning shall be replaced in kind. Notify the engineer of record in writing of all valves that require replacement. Failure to provide notification shall be replaced within contract price.
- H. Remove and reconnect any existing piping that shall remain active in service which interferes with the new architectural layout, ceiling devices, equipment, new ceiling heights and any unforeseen condition arising from the new modifications. All existing and new piping shall be located concealed behind new finished walls and above new ceilings whether specifically mentioned or not.

1.4 INSTALLATION OF PLUMBING SYSTEMS

- A. Contractor shall be responsible for all quantities of all equipment, materials and all associated appurtenances used on the project.
- B. Make plumbing connections to equipment, components, and appurtenances provided by other trades. Provide isolation valves, unions, flanges, traps, and appurtenances as required for a complete operational system.
- C. Install appropriate type backflow preventers in each water supply to incoming water mains to the facility, mechanical equipment, systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
- D. Prior to commencing installation of plumbing rough-in, coordinate final reviewed equipment shop drawings. Revise rough-in and final connections as required to correspond with the requirements of actual equipment, components, and appurtenances that will be installed.
- E. Rough-in, coordinate exact location and make final connections for the domestic water piping requirements provided from the equipment vendor for the following areas:
 - 1. Pantry Area Fixtures and Equipment
 - 2. Medical Gas Fixtures and Equipment
 - 3. Fire Protection Fixtures and Equipment
 - 4. Any Other System Fixtures and Equipment Requiring Plumbing Systems
- F. Arrange plumbing piping and connections to allow for easy equipment removal and access to other systems.
- G. All equipment such as water heaters, storage tanks, pumps, compressors, medical gas manifold systems, medical gas cylinders, whether specifically mentioned or not, shall be supported with the manufacturer's guidelines and in accordance with their respective standards, codes and regulations.
- H. The installation of Medical Gas Piping shall be prohibited from the following locations weather specifically mentioned or not:

1. Areas with Open Flames
 2. Areas where piping is subjected to contact with Fuel, Oil, etc.
 3. Electrical Closets
 4. Electrical Service Equipment Rooms
 5. Elevator Machine Rooms
 6. Elevator Shafts
 7. Fire Pump Rooms
 8. Incinerator Rooms
 9. Kitchens
 10. Laundry Rooms
 11. Stairwells
- I. Plumbing piping regardless of the system (sanitary, waste, vent, storm, or pressurized piping) shall not run in or pass through any Transformer Vaults, Main Distribution Frame Room-MDF, Electrical Switchgear Room, Emergency Power Room, Uninterruptible Power Supply Room-UPS, Electrical Closets, Intermediate Distribution Frame Room-IDF, Technology Distribution Room-TDR, Tele/Data Rooms, Operating Rooms, Cath Lab Rooms, Clean Sterile Areas and Similar Areas whether specifically mentioned or not. In existing or new construction where field conditions are unavoidable for the piping to run in these rooms such as plumbing fixtures located directly above these rooms, the piping shall be provided with a continuous drain pan. Piping shall not be located above any electrical panel under any circumstances. Where conditions permit Secondary Containment Piping System may be considered as described below in section "Secondary Containment Piping System". All work prior to installation shall be approved by Local authorities Having jurisdiction.
- J. Drain pans for piping shall be with 3" sides galvanized sheet metal drain pan with top rolled and no sharp edges. Slope pan towards drain pan discharge piping and extend 1-1/4" drain piping indirectly from the pan to the nearest mop receptor, service sink or indirect waste receptor. Provide label on the drain line to read: "Drain Pan Overflow – If water is discharging Contact Facilities Management". Provide leak detection system inside pan and extend the signal to BMS.
- K. Leak detection for drain pan shall be equal to Liebert Liqui-Tect 410 series. Connect 120-Volt to 24-Volt transformer to be provided with the unit to be plugged into a GFCI emergency power receptacle. Leak detection for pressurized piping shall be interlocked with a solenoid valve to shut-off the pressurized piping supply valve. In areas with hard ceiling, Provide access panels for valves and leak detector access.
- L. Any equipment installed such as, meters, pumps, flood control valves, etc. Shall be provided by means of connecting them to the Building Management System – BMS for continuous monitoring.
1. Discharge temperature to any drainage system shall not exceed 140 degrees. Where discharge temperatures exceed 140 degrees from any equipment, an aftercooler shall be provided to limit the discharge temperature to maximum 140 degrees.
 2. Hot Water Temperature to plumbing fixtures shall be limited between 105 to 120 degrees.
 3. Tempered water shall be provided to all public hand washing facilities through an approved water temperature limiting device conforming to ASSE 1070. Mixing valve shall be piped concealed below each individual lavatory and sink with an access panel.
 4. Public areas shall be defined by the Architect as bathroom groups having one or more lavatories or hand washing plumbing fixtures designated for public use.

5. Tepid water shall be delivered to emergency plumbing fixtures such as emergency eye wash, emergency shower, etc. Tepid Water temperature shall be delivered between 60 deg F and 100 Deg F. Tepid temperature shall be produced through a thermostatic mixing valve complying to ASSE 1071.

1.5 CUTTING AND PATCHING

- A. Provide cutting, patching and holes necessary to install the work specified herein.
 1. Use materials identical to in-place materials.
 2. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 3. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials, unless specified otherwise in other Sections.
 4. Fire Rated Elements: Do not cut and patch fire rated elements (i.e. floors, walls, roofs, shafts, etc.) in a manner that results in reducing their capacity to perform as intended or that results in decreased fire rating.
 - a. Where cutting and patching are required of fire rated elements and the resulting cutting reduces the capacity of the system to perform as intended, the Plumbing Contractor performing the cutting is responsible for repairing the assembly or for providing an engineering judgment to maintain the design intent rating.
 - b. Plumbing Contractor shall submit repair or engineering judgment to the Authorities Having Jurisdiction and the Architect / Engineer. All parties must approve the work prior to proceeding with the Work.
- B. No structural members shall be cut without prior approval of the Architect and the Structural Engineer.
- C. Provide ceiling removal and replacement where work above ceilings is required. Replace ceiling components damaged in the process.
- D. Documentation of effected systems shall be provided to the Architect / Engineer and Owner prior to any cutting and patching:
 1. List any services / systems that cutting and patching will disturb or affect.
 2. List services / systems that will need to be relocated and those that will be temporarily out of service. Indicate how long services / systems will be disrupted.
 3. Structural Elements: Where cutting and patching involve structural elements, submit details and exact locations to the Structural Engineer for review prior to cutting.

1.6 WATERPROOFING

- A. Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect / Engineer prior to performing work. Provide necessary sleeves, caulking and flashing required to make openings watertight.

1.7 AIR PLENUMS

- A. Plenums used as part of an air distribution system as defined by NFPA 90, shall be provided with materials tested in accordance with NFPA 255, ASTM E 84, and rated for plenum installation.
- B. Plumbing Contractor shall only utilize plenum rated piping materials, equipment and appurtenances in ceiling cavities used for environmental air purposes.

1.8 ELECTRICAL CONNECTIONS AND PROTECTION

- A. Regardless of voltage, provide control wiring, interlock wiring, and equipment control wiring for plumbing equipment provided under Division 22.
- B. Furnish electrical disconnect switches, starters and combination starter disconnects required for plumbing equipment provided under Division 22 to Electrical Contractor for installation. Circuit breakers furnished shall be rated for motor protection.
- C. Power wiring not used for control functions, from power source to motor or equipment junction box, including power wiring through starters, shall be provided under Division 26.
- D. Coordinate to ensure that electrical devices furnished or provided are compatible with the electrical systems used.
- E. Confirm final location of electrical equipment to be installed in the vicinity of piping.

1.9 ACCESSIBILITY

- A. Coordinate to ensure the sufficiency of the size of shafts, chases, the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.
- B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights, curtain tracks, speakers, etc. Equipment requiring access shall include, but is not necessarily limited to, valves, traps, clean outs, pumps, drain points, etc.
- C. Indicate the locations of access doors for each concealed valve, piece of equipment, components, or other device concealed behind finished construction and requiring service on the coordination drawings.
- D. Maintain clearances around equipment equal to or greater than the code required minimums.

1.10 PAINTING

- A. Painting requirements of this section shall conform to Division 01 – Painting.
- B. Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.
- C. Provide field painting of systems, equipment and miscellaneous metals located outdoors. Application shall be in strict accordance with manufacturer's recommendations.

- D. Provide painting of plumbing piping and equipment exposed in mechanical equipment room and in occupied spaces. Plumbing items to be painted are as follows:
 - 1. Piping, pipe hangers, pipe insulation, and supports
 - 2. Equipment and supports.
 - 3. Tanks.
 - 4. Accessory items.
- E. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

1.11 CLEANING, PROTECTION AND ADJUSTMENT

- A. Cleaning
 - 1. Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed. Clean, polish, and leave equipment, accessories, and trim in first-class condition.
- B. Protection of Surfaces
 - 1. Protect surfaces from damage during the construction period.
 - 2. Provide plywood or similar material under equipment or materials stored on floors or roofs. Provide protection in areas where construction may damage surfaces.
 - 3. Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Owner and Architect.
- C. Protection of Services
 - 1. Protect services from damage during the construction period.
 - 2. Repair, replace and maintain facilities or services damaged, broken or otherwise rendered inoperative during the course of construction.
 - 3. Services damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the service shall be approved by the Owner and Architect.
- D. Protection of Equipment and Materials
 - 1. Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on site in open or unprotected areas, equipment and material shall be kept off the ground and out of standing water by means of pallets or racks and covered with tarpaulins.
 - 2. Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Architect or manufacturer the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.

3. During the construction period, protect piping, fittings, valves, equipment and associated appurtenances from damage and dirt. Each system of piping shall be flushed to remove grit, dirt, sand, and other foreign matter for as long a time as required to thoroughly clean the systems.
4. Protect all types of existing and new drains during construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

E. Adjustment

1. After the entire installation has been completed, make required adjustments to balancing valves, circulating systems, pressure reducing valves and similar devices until performance requirements are met.
2. Provide factory-lubricated bearings for equipment. Before initial startup of equipment, inspect and verify bearings for proper amounts of lubricant. If required, provide proper amounts of lubricant in accordance with manufacturer's recommendations.

1.12 SPECIAL TOOLS

- A. Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

1.13 SOLDERING

- A. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

1.14 WELDING

A. General Requirements

1. This paragraph covers the welding of systems. Deviations from applicable codes, approved procedures and approved shop drawings shall not be permitted. Materials or components with welds made off site shall not be accepted if the welding does not conform to the requirements of this specification. Develop and qualify procedures for welding metals included in the work. Certification testing shall be performed by an approved independent testing laboratory. Bear costs of such testing.
2. Certified welders, previously certified by test, may be accepted for the work without re-certification if all of the following conditions are fulfilled:
 - a. Submit copies of welder certification test records in accordance with this Division and Division 01 requirements.
 - b. Testing was performed by an independent testing laboratory.
 - c. The welding procedures and welders are certified in accordance with the "ASME Boiler and Pressure Vessel Code," and base materials, filler materials, electrodes, equipment, and processes conform to the applicable requirements of this specification.
 - d. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
 - e. Certification has been within a one (1) year period from the start of the project.

3. Filler metals, electrodes, fluxes and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to assure safe handling.
4. Submit welding certificates for review. Each welder assigned to work covered by this specification shall be certified by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires.
5. Before assigning welders to the work, provide the architect with their names, together with certification that everyone is certified as specified. No welding work shall start prior to submissions. The certification shall state the type of welding and positions for which each is certified, the code and procedure under which each is certified, date certified, and the firm and individual certifying the certified tests.
6. Each welder shall be assigned an identifying number, letter, or symbol that shall be used to identify his welds. A list of the welders' names and symbol for each shall be submitted. To identify welds, either written records indicating the location of welds made by each welder shall be submitted, or each welder shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3-foot intervals. Identification by die stamps or electric etchers shall be confined to the weld reinforcing crown, preferably in the finished crater.

1.15 DIELECTRIC FITTINGS

- A. Ferrous to non-ferrous pipe connections shall be made with threaded, soldered, plain, or welded end connections that match piping system material. Dielectric fittings shall prevent any electrolytic action between dissimilar materials.

1.16 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral water-stop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 1. Under deck Clamp: Clamping ring with set screws.

1.17 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.
- C. One-Piece, Floor-Plate Type: Cast-iron floor plate.

PART 2 - PRODUCTS

2.1 PROTECTION OF ELECTRICAL EQUIPMENT

- A. Plan and arrange overhead piping to avoid dedicated electrical space that may include motors, controllers, switchboards, panel boards, or similar equipment.
 - 1. Dedicated electrical space is equal to the width and depth of the electrical components and extends from the floor to a height of 6 feet above the electrical components or to the structural ceiling, whichever is lower. No piping, leak detection apparatus, equipment, components or associated appurtenances foreign to the electrical installation shall be located in the dedicated electrical space.
 - 2. Dropped, suspended, or any other type of ceiling that does not add strength to the building structure cannot be provided as a separation between dedicated electrical space for the installation of foreign components within the dedicated electrical space.
- B. Where the installation of foreign components occurs above the dedicated electrical space (6 feet above the electrical systems), contractor shall provide a means of secondary containment to prevent damage to the electrical systems.
- C. Secondary containment shall consist of gutters as follows:
 - 1. Provide gutter of 16 ounce cold rolled copper or heavy galvanized steel, under every pipe.
 - 2. Each gutter shall be soldered and made watertight, properly suspended and carefully pitched to a convenient point for draining. Provide a ¾-inch drain line with normally open valve as directed to nearest floor drain mop receptor or indirect waste basin.
 - 3. In lieu of such separate gutters, a continuous protecting sheet of similar construction supported, braced, properly rimmed, pitched and drained, may be provided.
- D. Secondary Containment Piping System
 - 1. Piping system shall consist of clear unpigmented Polyvinyl Chloride pipe and fittings. The containment piping system shall be longitudinally split. The pipe shall align via a tongue and groove and the fittings shall be manufactured in two halves.
 - 2. The pipe and fitting shall be temporarily held together by clips affixed over top of integral fitting clip locators. Final system joining shall be provided by welding components together via an injection bonding process.
 - 3. Final containment inspection shall be provided via a low-pressure air test per manufacturer's requirements.
 - 4. Manufacturer
 - a. Georg Fischer - GF Piping Systems, LLC - Model Contain-It.
 - b. R & G Sloan Manufacturing.

2.2 ACCESS DOORS

- A. Unless otherwise noted, access doors shall be a minimum of 18-inch x 18-inch or as directed by the Architect / Engineer where space may be limited. In areas with fire-rated partitions the access door shall be of fire-rated type. Access doors manufactured as an integral unit, complete with all parts, accessories and ready for installation.

- B. Access doors and frames shall be of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.
- C. Frames shall be fabricated from 16-gauge steel.
 - 1. Fabricate frame with exposed flange nominal 1-inch wide around perimeter of frame for units installed in the following construction:
 - a. Exposed Masonry
 - 2. For gypsum drywall or veneer gypsum plaster, furnish perforated frames with drywall bead.
 - 3. For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
 - 4. For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame
- D. Flush Panel Doors shall be fabricated from not less than 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175°. Finish with manufacturer's factory-applied prime paint.
 - 1. For fire-rated units, provide manufacturer's standard insulated flush fire-rated panel/doors, with continuous piano hinge and self-closing mechanism.
- E. Locking devices shall be flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.
- F. Manufacturers:
 - 1. Bar-Co., Inc.
 - 2. J. L. Industries
 - 3. Karp Associates, Inc.
 - 4. Nystrom, Inc.

2.3 WELDING

- A. Welding materials shall comply with the "ASME Boiler and Pressure Vessel Code." Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a certified welder using qualified welding procedures.

2.4 DIELECTRIC FITTINGS

- A. Dielectric unions shall be factory – fabricated assemblies with a minimum working pressure as required to suit system pressures.
- B. Dielectric flanges shall be factory – fabricated, companion flange assemblies with a minimum working pressure as required to suit system pressures.
- C. Dielectric flange kits shall be field – fabricated with a minimum working pressure as required to suit system pressures. Kit shall include flanges, full face type phenolic gasket, phenolic bolt sleeves, phenolic washers, and steel backing washers.

- D. Dielectric couplings shall be galvanized steel with inert and noncorrosive, thermoplastic lining, threaded ends and a minimum working pressure as required to suit system pressures.
- E. Dielectric nipples shall be electroplated steel nipple with inert and noncorrosive, thermoplastic lining, plain, threaded, or grooved ends and a minimum working pressure as required to suit system pressures.
- F. Manufacturers
 - 1. Sioux Chief Industries
 - 2. Watts Industries
 - 3. Zurn Industries

PART 3 - EXECUTION

3.1 ACCESS DOORS AND ACCESS PANELS

- A. Coordinate access doors and access panel locations with all trades during coordination drawing phase.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas. Do not install any piping behind walls where door hinges will be located, e.g. shower doors.
- C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- D. Install piping to permit valve servicing.
- E. Install piping at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation where applicable.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece cast brass type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.

- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
2. Existing Piping: Use the following:
- a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
 - g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- K. Sleeves are not required for core-drilled holes.
- L. Permanent sleeves are not required for holes formed by removable PE sleeves.
- M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

- d. Seal space outside of sleeve fittings with grout.
 - e. Seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for materials. Fire sealant shall be classified and/or FM approved and tested to the requirements of ASTM E814 (UL 1479). Chemicals used in the firestopping materials shall be of the type that does not have adverse effect on the firestopping regardless of piping material.
- P. Verify final equipment locations for roughing-in.
- Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
- 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- 1. Perform welding in accordance with qualified procedures using certified welders. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. Welding of hangers, supports, and plates to structural members shall conform to AWS specifications.

2. Field bevels and shop bevels shall be by mechanical means or by flame cutting. Where beveling is by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding. Beveling shall conform to ANSI B31.1 and AWS B3.0.
 3. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening shall not be permitted. Welders responsible for defective welds must be re-certified.
 4. Store electrodes in a dry heated area; keep free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2-inches and smaller, adjacent to each side of in-line pumps, valves, gauges, thermometers, or other components and at final connection to each piece of equipment.
 2. Install flanges, in piping 2-1/2-inches and larger, adjacent to each side of in-line pumps, valves, gauges, thermometers, or other components and at final connection to each piece of equipment.
 3. Install dielectric union, couplings, nipple fittings and flanges to connect piping materials of dissimilar metals.

END OF SECTION 220500

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe bends and loops.
 - 2. Pipe alignment guides.
 - 3. Swivel joints.
 - 4. Pipe anchors.
 - 5. Fasteners.

1.3 REFERENCES

- A. General: Comply with appropriate standards.

- 1. American Welding Society: AWS.
- 2. Underwriters' Laboratories: U.L.

1.4 DEFINITIONS

- A. General acronyms are listed below for general information. Not all acronyms are used in this text:

- 1. ABS: Acrylonitrile-butadiene-styrene plastic.
- 2. BR: Butyl rubber.
- 3. Buna-N: Nitrile rubber.
- 4. CR: Chlorosulfonated polyethylene synthetic rubber.
- 5. CSM: Chlorosulfonyl-polyethylene rubber.
- 6. EPDM: Ethylene-propylene-diene monomer rubber.
- 7. LLDPE: Linear, low-density polyethylene plastic.
- 8. NBR: Acrylonitrile-butadiene rubber.
- 9. NR: Natural rubber.
- 10. PE: Polyethylene plastic.
- 11. PP: Polypropylene plastic.
- 12. PVC: Polyvinyl chloride plastic.
- 13. PVDF: PolyVinylidene Fluoride
- 14. TFE - Tetra-Fluoro Ethylene.

1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Design: After coordination of MEP systems has been completed and the coordination drawings signed by all of the trades in accordance with Section 230000, any piping system shown on the documents requiring anchors and guides shall be located on the coordination plans by a qualified professional engineer. Further, the supports connecting the guides and anchors to the building structure shall be designed by a qualified professional engineer.
- B. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.
- C. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. First paragraph below is defined in Division 01 Section "Submittal Procedures" as a "Delegated-Design Submittal." Retain if Work of this Section is required to withstand specific design loads and design responsibilities have been delegated to Contractor or if structural data are required as another way to verify compliance with performance requirements. Professional engineer qualifications are specified in Division 01 Section "Quality Requirements."
- C. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- D. Welding certificates.
- E. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.
- F. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
 - 2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

2.2 PIPE BENDS AND LOOPS

- A. Provide pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Provide manufactured expansion device or fabricated expansion loop on all piping systems crossing building expansion joints.
- C. On all piping systems except hot water and hot water return systems, Provide Expansion loops spaced at 100 feet intervals on straight piping.
- D. On hot water and hot water return piping systems, Provide Expansion loops spaced at 100 feet intervals on straight piping.
- E. Provide expansion loops at mid-point of piping span, provide pipe guides at each side of the loop and anchors at each piping end. Secure all guides and anchors to building structure.

2.3 SWIVEL JOINTS

- A. Swivel Joints: Fabricated steel Bronze Ductile Iron Cast steel body, double ball bearing race, field lubricated, with rubber Buna-N rubber O-ring seals.

2.4 PIPE ANCHORS

- A. Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.
- C. Washers: ASTM F 844, steel, plain, flat washers.

2.5 FASTENERS

- A. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland Cement Concrete and tension and shear capacities appropriate for application.
 - 1. Stud: Threaded, zinc-coated carbon steel.
 - 2. Expansion Plug: Zinc-coated steel.
 - 3. Washer and Nut: Zinc-coated steel.
- B. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened Portland Cement Concrete, and tension and shear capacities appropriate for application.
 - 1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - 2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - 3. Washer and Nut: Zinc-coated steel.

- C. Concrete: Portland cement mix, 3000 psi (20.7 MPa) minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.
- D. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink, nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Non-staining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 PIPE BEND AND LOOP INSTALLATION

- A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Attach pipe bends and loops to anchors.
 - 1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.2 SWING CONNECTIONS

- A. Connect risers and branch connections to mains with at least three pipe fittings, including tee in main.

3.3 ANCHOR INSTALLATION

- A. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Coordinate first paragraph below with structural Sections and Drawings if welding is included in structural work.
- C. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.
- D. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
- E. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints are indicated.
- F. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION 220516

SECTION 220523 - PLUMBING VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 GENERAL

- A. Provide manual valves as shown on the drawings and /or as specified herein, and as required for proper control and maintenance of plumbing systems and equipment.
- B. Valves shall be the product of one manufacturer except for special applications.
- C. Valves shall be of same minimum working pressure and materials as specified for fittings of the system in which they are installed. Regardless of service, valves shall be designed for a minimum 125 psi steam working pressure.
- D. Install valves in accessible locations.
- E. Valves for equipment shutoff shall be size of pipe indicated on the drawings before reducing to equipment size.
- F. Valves in mechanical equipment rooms above 7 feet shall have chain wheel operators.
- G. Valves shall comply with Federal Law 111-380 "Reduction of Lead in Drinking Water Act"
- H. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUMMARY

- A. This section includes the following:
 - 1. General requirements for valves
 - 2. Ball Valves
 - 3. Drain valves
 - 4. Check Valves
 - 5. Balancing Valves
- B. Related Sections:
 - 1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
 - 2. Division 22 Section " Identification for Piping, Valves and Equipment " for valve tags and schedules.

1.4 DEFINITIONS

A. This section includes the following:

1. Retain terms that remain after this Section has been edited for a project.
2. ANSI: American National Standards Institute.
3. Buna-N: Nitrile copolymer of butadiene and acrylonitrile.
4. CSA: Canadian Standards Association.
5. CWP: Cold working pressure.
6. EPDM: Ethylene propylene-diene monomer rubber.
7. NSF: National Sanitation Foundation.
8. NRS: Non-Rising stem
9. OS&Y: Outside screw and yoke
10. PTFE: Polytetrafluoroethylene.
11. RS: Rising stem
12. TFE: Tetrafluoroethylene.
13. UL: Underwriters Laboratory.
14. WOG: Water, Oil, and Gas.
15. WSP: Working steam pressure.

1.5 SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that brass or bronze ball valves comply with NSF 372 or NSF 61, Annex G.

1.6 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF/ANSI 61-G and/or NSF/ANSI 372 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

1.7 DELIVERY, STORAGE AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.
 3. Set angle valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Contractor shall be responsible for all quantities of all equipment, materials and all associated appurtenances used on the project.
- B. Refer to valve schedule articles for applications of valves.
- C. Lead Free silicon bronze (ASTM listed) valves shall be made with corrosion-resistant materials. Manufacturer shall provide third party certification tested in accordance with EN ISO 6509 regarding dezincification corrosion resistance and stress corrosion cracking.
- D. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
1. Valve solder-joint connections are common in smaller sizes of plumbing piping. Soldering and brazing methods used to achieve required pressure-temperature ratings may damage internal valve parts. Special installation requirements for soldered valves may make threaded valves more cost-effective.
 2. Caution: Use solder with melting point below 421 deg F.
 3. ASME B16.18 for solder-joint connections.
 4. ASME B31.9 for building services piping valves.
- E. NPS 2-inch and smaller with Threaded or soldered.
- F. NPS 2-1/2-inch and larger with flanged ends, unless otherwise indicated.
- G. Medical gas valves shall be with brazed connections.
- H. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- I. Valve Sizes: Same as upstream piping unless otherwise indicated.
- J. Valve Actuator Types:

1. Hand lever: For quarter-turn valves NPS 6-inch and smaller.
 2. Chainwheels: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- K. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Ball Valves: With extended operating handle of non-thermal-conductive material that meets UL 2043 approved for inside air plenum, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation and memory stops that are fully adjustable after insulation is applied
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO NIB-SEAL (-NS suffix in figure no.), or (-LX for locking extensions) handle extension or approved equal.
- L. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
 2. Solder Joint: With sockets according to ASME B16.18.
 3. Threaded: With threads according to ASME B1.20.1.
 4. Copper Press: With sockets according to ASME B16.22/ASTM B75
 5. Brazed: With sockets according to AWS B2.2/B2.2M
- M. Valve Bypass and Drain Connections: MSS SP-45.
- 2.2 BALL VALVES:
- A. One-piece ball valves shall not be employed on the project.
- B. Two-piece ball valves shall be applicable to Plumbing System use Only.
- A. Three-piece ball valves shall be applicable to Medical Gas Piping Systems. Other types of ball valves shall not be employed in Medical Gas Piping Systems.
1. All maintenance valves used in medical gas systems shall be equipped with locking device and be locked in open position.
- C. Two-Piece Ball valves:
1. Basis-of-Design Product: Two-Piece, full port, silicon bronze ball valves with the capability of accepting extended operating handles.
 2. Manufacturers: Subject to compliance with requirements, provide products by manufacturers listed above in general requirements for valves.
 3. Description:
 - a. Standard: MSS SP-110 and ASME A1124.14
 - b. CWP Rating: 600 – 1000 psig

- c. Body Design: Two piece with reversible handle, adjustable pack nut design (no threaded stem designs allowed) with triple sealed stem packing
 - d. Body Material: Silicon bronze (ASTM Listed), corrosion resistant
 - e. Ends: Soldered.
 - f. Seats: Reinforced RPTFE
 - g. Stem: Stainless steel
 - h. Ball: Stainless steel
 - i. Port: Full
 - 4. Manufacturer and Model: (Soldered End Connections)
 - a. Apollo Valve – Model 77FLF-200-04
 - b. Watts Valve – Model LFB6081G2-XH
 - c. Milwaukee Valve – Model UPBA450S-XH
- D. Three-Piece Ball valves:
- 1. Basis-of-Design Product: Three-Piece, full port, silicon bronze ball valves with the capability of accepting extended operating handles.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by manufacturers listed above in general requirements for valves.
 - 3. Description:
 - a. Standard: MSS SP-110 and ASME A1124.14
 - b. CWP Rating: 600 psig
 - c. Body Design: Three-piece bronze with threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing
 - d. Body Material: Silicon bronze (ASTM Listed), corrosion resistant
 - e. Ends: Brazed
 - f. Seats: PTFE
 - g. Stem: Stainless steel
 - h. Ball: Brass
 - i. Port: Full
 - 4. Maintenance valves shall be equipped with locking type handles.
 - 5. Manufacturer and Model:
 - a. Beacon Medaes – Model HTM2022
 - b. Amico – Model W-ISO-G
 - c. Apollo Valve – Model 82-200

2.3 DRAIN VALVES:

- A. Two-Piece Ball-Valve-Type, Hose-End Drain Valves:
 - 1. Basis-of-Design Product: Two-Piece, full port, silicon bronze ball valves with the capability of accepting extended operating handles.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by manufacturers listed above in general requirements for valves.

3. Description:
 - a. Standard: MSS SP-110 and ASME A1124.14
 - b. CWP Rating: 600 psig.
 - c. Size: NPS 3/4.
 - d. Body Design: Two-piece bronze with threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing.
 - e. Body Material: Silicon bronze (ASTM Listed), corrosion resistant.
 - f. Hose Body End Material: Silicon bronze (ASTM Listed), corrosion resistant.
 - g. Ends: Threaded or soldered. Press fit per local jurisdictions
 - h. Seats: Reinforced PTFE or TFE.
 - i. Stem: Stainless steel (silicon bronze available).
 - j. Ball: Stainless steel.
 - k. Port: Full.
 - l. Cap: Die Cast Brass, EPDM Gasket
 - m. Pop Rivet: Stainless Steel.
 - n. Handle: Vinyl-covered steel.
 - o. Inlet: Threaded or solder joint.
 - p. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.
4. Manufacturer and Model:
 - a. Apollo Valve – Model 70LF HC
 - b. Watts - Equivalent
 - c. Milwaukee - Equivalent

2.4 CHECK VALVES

A. Silicon bronze swing check valves

1. Basis-of-Design Product: 200 CWP, Bronze Swing Check Valves with TFE Disc.
2. Manufacturers: Subject to compliance with requirements, provide products by manufacturers listed above in general requirements for valves.
3. Description:
 - a. Standard: MSS SP-139
 - b. CWP Rating: 300 psig
 - c. Body Design: Horizontal or vertical (flow in upward direction) flow
 - d. Body Material: Silicon bronze (ASTM Listed), corrosion resistant
 - e. Ends: Threaded or soldered. Press fit per local jurisdictional
 - f. f.Disc: Brass
4. Manufacturer and Model (Soldered)
 - a. Crane – Model LF37
 - b. Apollo – Equivalent
 - c. Watts – Equivalent

2.5 BALANCING VALVES

A. Calibrated Balancing

1. Balancing valves 2 inches and smaller shall be lead free bronze body / brass ball. Valve shall have differential pressure read out ports with check valve, tapped drain / purge port, memory stop, and calibrated nameplate.
2. Balancing valve assembly shall be provided with two ball valves, one check valve, and one thermometer.
3. Balancing valve assembly shall be calibrated for 130 F hot water return.
4. Manufacturer and Model (Soldered End Connection)
 - a. Watts – Model LFCSM-61-S
 - b. Bell & Gossett – Model Circuit Setter Plus

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Provide shut off valves at each branch connection to supply main and at each plumbing fixture and/or equipment requiring plumbing service regardless of whether shown on the drawings.
- B. Examine valve interior for cleanliness, valves shall be free from foreign matter and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- E. Examine mating flange faces for damage. Check bolting for proper size, length and material. Verify that gasket is of proper size, that its material composition is suitable for service and that it is free from defects and damages.
- F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Provide valved and capped piping for future use. Pipe caps shall be installed minimum 2'-0" away from end of valve.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in position to allow full stem movement.

- E. Valves shall be provided with stem extensions when installed on insulated piping.
- F. When soldering use paste fluxes that are approved by the manufacture for use with Lead Free Alloys. Rubber seats and or rubber gaskets shall be removed prior to soldering and reinstalled after the soldering is complete. Test for leaks and repair/replace valve until there are no leaks.
- G. Install shut-off valves at all piping main take-offs from risers and at all branch connections in all piping systems.
- H. Provide isolation valves for all equipment before and after all control valves.
- I. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
- J. Install balancing valves in locations where they can easily be adjusted.
- K. Install stamped brass valve tags. Comply with requirements in Section 220553 "Identification for Piping Valves and Equipment" for valve tags and schedules.
- L. Provide Excel Format valve chart with all valves recorded and identified with their numbers, service types, sizes and location as part of the as-builts.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 220523

SECTION 220529 - PLUMBING HANGERS, SUPPORTS AND SLEEVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Systems used on this project shall be in accordance with Owner's Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner prior to final product purchase.

1.2 HANGERS AND SUPPORTS

- A. Provide hangers and supports as shown on the drawings and/or as specified herein.

1.3 SLEEVES

- A. Provide sleeves as shown on the drawings and /or as specified herein.

1.4 SEISMIC REQUIREMENTS

- A. Where applicable, provide seismic restraint hangers, supports, and associated appurtenances for piping and equipment in accordance with building code requirements.

1.5 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Pipe hangers and supports.
 - 2. Steel pipe hangers and supports.
 - 3. Trapeze pipe hangers.
 - 4. Metal framing systems.
 - 5. Anchors
 - 6. Pipe stand Fabrications.
 - 7. Pipe positioning systems.
 - 8. Equipment supports.
 - 9. Miscellaneous materials.
 - 10. Sleeves
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
 - 3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.6 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.7 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design all pipe hangers, equipment supports and concrete anchors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
- C. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents and test water.

1.8 SUBMITTALS

- A. Product Data: For the following:
 1. Steel pipe hangers and supports.
 2. Concrete Inserts
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 1. Trapeze pipe hangers. Include Product Data for components.
 2. Metal framing systems. Include Product Data for components.
 3. Pipe stands. Include Product Data for components.
 4. Equipment supports.
- C. Delegated-Design Submittal: For pipe hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Welding certificates.

1.9 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." AWS D1.4, "Structural Welding Code--Reinforcing Steel." ASME Boiler and Pressure Vessel Code: Section IX.
- B. Welding: Qualify procedures and personnel according to the following:
 1. AWS D1.1, "Structural Welding Code--Steel."

2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. General

1. Provide hangers and supports as specified herein.
2. Hanger design shall conform to Federal Specification WWH-171; Manufacturers Standardization Society ANSI / MSS-SP-58; and installed in accordance with ANSI / MSS-SP-69.
3. Hangers, anchors, and supports shall support the plumbing piping and contents of the piping. Hangers and strapping material shall be of an approved material that will not promote galvanic action.
4. Sanitary, storm, and secondary storm piping shall be anchored to restrain pipe from axial movement. Drainage piping shall be provided with hangers:
 - a. Within 18 inches on both sides of a coupling
 - b. At all changes of direction
 - c. At all changes in diameter greater than two pipe sizes.
5. For gravity drainage piping, provide adjustable spring hangers on both sides of building expansion joints.
6. Flexible connections shall not be permitted in gravity drainage and Medical Gas Piping Systems.
7. Rigid support sway bracing shall be provided at changes in direction greater than 45 degrees for pipe sizes 4 inches and larger.
8. Restraints shall be provided for drain pipes greater than 4 inches at all change of direction and at all changes in diameter greater than two pipe sizes. Braces, blocks, rodding, and other approved methods as specified by the coupling manufacturer shall be utilized.
9. Hangers and supports shall secure pipes in place, prevent vibrations, maintain required pitch, and provide free expansion and contraction. Support shall be provided to support the loading and service, and not over stress the building structure.
10. Resilient hangers and isolation devices shall be provided on piping connected to rotating equipment, including pumps, and on other piping which may vibrate and create audible noise.
11. Hanger rods shall be threaded with a minimum of 1½ inches thread exposed on each end after the nut. The rod material shall be either cadmium plated or galvanized steel.
12. Specified bracket clamp and rod sizes are minimum sizes. Support and hanger design shall include a safety factor of 5.
13. Where several pipes 4 inches in diameter and smaller can be installed parallel and at the same elevation, approved trapeze hangers may be provided in lieu of separate hangers with suspension rods.
 - a. Trapeze hangers shall be braced to prevent motion due to expansion and contraction of piping.

- b. Trapeze hangers spacing shall be provided based on the requirements of the smallest pipe on the trapeze.
- 14. Plastic coated hangers and clamps shall be provided for non-insulated brass, copper pipe, polypropylene, PVDF, and similar type pipe materials unless shields are provided between hangers or clamps and pipe.
- 15. Provide supplemental steel when required for support of pipes.
- 16. Pipe hangers and supports shall be surely anchored to building structure. Hangers and supports are not permitted to be attached to other piping, conduit, ductwork, or other such components.
- 17. Piping located near floors that can be supported from floor or walls shall be provided with approved floor stands, wall brackets, roller supports, masonry piers or similar items.
- 18. Hangers and supports for horizontal piping shall provide a means of vertical adjustment after erection.
- 19. Vertical piping shall utilize riser clamps specifically designed for piping.
- 20. Hangers for piping with insulation shall be provided with insulation inserts and protection shields.
- 21. Hangers or supports shall be provided as required to stabilize and re-support any existing piping that is to remain and be reused in areas affected by demolition.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

- B. Available Manufacturers:

Hanger Type	PHD	Erico	B-Line	Anvil International
Adjustable center load beam clamp	630	360	B3054	218
Standard clevis hanger	450	400	B3100	260
Insulated pipe clevis hanger	430	403	B3108	300
Copper tubing clevis hanger	442	402	B3104CT	CT-65
Standard riser clamp	550	510	B3373	261
Copper riser clamp	552	511	B3373CT	CT-121
Double bolt pipe clamp	525	450	B3140	295
Underground pipe clamp	580	---	B3132	---
Straight J-hook	810	458	B3191	---
Adjustable pipe saddle support with U-bolt	876	724	B3092	259
Standard U-bolt	90	150	B3188	137
Welded beam attachment	900	320	B3083	66
Welded steel bracket, heavy duty	860	353	B3067	199

Hanger Type	PHD	Erico	B-Line	Anvil International
Welded steel bracket, light duty	855	352	B3066	195
Concrete insert	950	355	B2505	282
180 - degree shield	170	125	B3151	167

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 HANGER ROD SCHEDULE

PIPE SIZE	MINIMUM ROD SIZE
UP TO 2 INCHES	3/8 INCH DIAMETER
2 1/2 INCHES TO 4 INCHES	1/2 INCH DIAMETER
4 INCHES TO 5 INCHES	5/8 INCH DIAMETER
6 INCHES	3/4 INCH DIAMETER
8 INCHES TO 12 INCHES	7/8 INCH DIAMETER

2.4 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 DRILLED-IN ANCHORS

A. Drilled-In Anchors

1. Wedge Anchors: Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers.
 - a. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193.
 - b. Interior Use: Provide carbon steel anchors with zinc plating in accordance with ASTM B633.
2. Manufacturer
 - a. Hilti
 - b. DeWalt
 - c. Powers

2.7 PIPE STAND FABRICATIONS

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
 1. Available Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
 1. Available Manufacturers:
 - a. MIRO Industries.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 1. Available Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 2. Base: Stainless steel.
 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

- 1. Available Manufacturers:

- a. Portable Pipe Hangers.
 - 2. Bases: One or more plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

- B. Available Manufacturers:

- 1. C & S Mfg. Corp.
 - 2. HOLDRITE Corp.; Hubbard Enterprises.
 - 3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - a. Properties: Non-staining, non-corrosive, and non-gaseous.
 - b. Design Mix: 5000-psi, 28-day compressive strength.

2.11 SLEEVES

- A. Provide sleeves for piping passing through walls, floors, ceilings, roofs, structural members, and other building parts. Sleeves shall be securely fastened to the assembly penetrated.
 - 1. Through penetration of fire-resistance-rated walls

- a. Annular space between sleeves and pipes shall be protected by an approved UL listed through - penetration fire stop system installed and tested in accordance with ASTM E814, with a minimum positive pressure differential of 0.01 inch of water and shall have an F rating of not less than the required fire resistance rating of the wall penetration.
 - b. Sealant in one-hour and two-hour walls shall be UL listed and installed in accordance with manufacturer's recommendations.
 - c. Manufacturers:
 - 1) Hilti
 - 2) Pro Set
2. Through penetration of fire-resistance-rated floor and roof assemblies
 - a. Annular space between sleeves and pipes shall be protected by an approved UL listed through - penetration fire stop system installed and tested in accordance with ASTM E814, with a minimum positive pressure differential of 0.01 inch of water. The system shall have an F rating and a T rating of not less than one hour but not less than the required rating of the floor penetration
 - b. Sealant in one-hour and two-hour floors shall UL listed and installed in accordance with manufacturer's recommendations.
 - c. Manufacturers:
 - 1) Hilti
 - 2) Pro Set
3. Through penetrations of non-fire-resistance-rated walls and floors.
 - a. Annular space between sleeves and pipes in non-fire-resistance-rated assemblies shall be filled or tightly caulked in an approved manor.
 - b. Sealant for general purpose use and for Kitchen, Food Preparation, and Dining areas shall be provided in accordance with manufacturer's recommendations.
 - c. Manufacturers:
 - 1) Hilti
 - 2) Pro Set

PART 3 - EXECUTION

3.1 GENERAL

- A. Piping passing through roof construction shall be arranged to provide a minimum of 12-inch clearance from walls or other obstructions so as to permit proper flashing. Set pipe flashing fittings at a suitable level above the roof to permit proper termination of flashing.
- B. Hangers shall be attached to building construction.
- C. Do not support piping from ceiling supports, ductwork, equipment, cable trays, electrical conduit or other piping.
- D. No piping shall be hung from metal floor deck, metal roof deck or steel joists.

- E. Pipes 4-inch diameter and larger shall not be supported from new or existing slab on metal deck without prior approval from the building structural engineer. The proposed hanger layout and loads shall be submitted by the Plumbing Contractor for approval by the structural engineer prior to installation.
- F. Secure pipe hangers attached to existing concrete structures and slabs with mechanical expansion anchors or powder-actuated fasteners.
- G. Supplemental Steel: Where hangers do not correspond with the structural steel in the building structure provide supplemental steel members fastened to the building's structural steel frame.
- H. Pipes shall not be supported from new or existing slab on metal deck without prior approval from the building structural engineer of the proposed hanger layout and loads. The hanger layout and loads to be submitted for approval must first be coordinated with other trades and submitted together showing all hangers with the load reactions for all trades superimposed on a single document.
- I. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- J. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- K. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- L. Use padded hangers for piping that is subject to scratching.
- M. Horizontal-Piping Hangers and Supports: Space the hangers so that the supported load does not exceed the load recommended by the hanger manufacturer. Space the hangers so they do not exceed the support spacing requirements listed in the piping system Sections. The supported load shall not overstress the building structural members unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
 - 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 4. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 8. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 9. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

10. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 SUPPLEMENTAL STEEL

- A. Unless otherwise approved by the structural engineer, only attach hangers to the building structural steel beams. Where hangers do not correspond with the building structural beams, provide supplemental steel members fastened to the building structural steel beams.
- B. Submit details of hanger attachments to the building structure to the structural engineer for approval before drilling or burning holes in the structure.
 - 1. Slab on Deck Construction: Do not support hangers from the underside of slab on metal deck, without the building structural engineer's approval of proposed hanger loads and layouts.

3.3 PIPE HANGERS AND SUPPORTS

A. Pipe Support Spacing

<u>Piping Material</u>	<u>Maximum Horizontal Spacing</u>	<u>Maximum Vertical Spacing</u>
Cast Iron Pipe	5 Feet	15 Feet
Copper or copper-alloy tubing,	12 Feet	10 Feet
Copper or copper-alloy tubing, 1	6 Feet	10 Feet
1/4 inch diameter and smaller		
Copper or copper-alloy tubing, 1	10 Feet	10 Feet
1/2 inch diameter and larger		
Steel Pipe		
1/2 inch	6 Feet	6 Feet
3/4 inch and 1 inch	8 Feet	8 Feet
1-1/4 inch and larger	10 Feet	10 Feet
Polypropylene	4 Feet	10 Feet
Polyvinylidene	4 Feet	10 Feet

3.4 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in existing lightweight concrete or concrete slabs less than 4 inches thick in concrete. Use operators that are licensed by power-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in existing concrete. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install cross bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- O. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

- b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
- 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood inserts.
- 6. Insert Material: Length at least as long as protective shield.
- 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.5 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.
- D. Provide cross bracing, to prevent swaying, for equipment supports.

3.6 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.8 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All materials, installation procedures and selection of manufacturers of all Systems used on this project shall be in accordance with Owner's Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner prior to final product purchase.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Pipe identification labels
 - 2. Valve tags
 - 3. Valve schedules and charts
 - 4. Zone valve box labels
 - 5. Medical equipment labels and name plates
 - 6. Ceiling markers for concealed equipment, valves and devices
 - 7. Warning signs and labels

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PIPE IDENTIFICATION LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
- E. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
- F. Lettering Size: At least 1-1/2 inches high.
- G. Interior
 - 1. Pipe bands indicating contents and flow direction shall be flexible vinyl film with acrylic pressure sensitive adhesive suitable for pipe surface temperatures of -40°F to 220°F.
 - 2. Manufacturer and Model
 - a. Seton – Opti-Code
 - b. Brady – Model B-946
 - c. Bunting, Inc.
- H. Pipe marking shall comply with ANSI A13.1 Scheme for the Identification of Pipe Systems. Markers shall be in compliance with respect to:
 - 1. Marker length
 - 2. Background color
 - 3. Letter color
 - 4. Letter size
- I. Medical gas pipe markings shall comply with the requirements of NFPA 99
 - 1. Medical gas pipe markings shall include the following:
 - a. Name of the gas or vacuum system or the chemical symbol of the medical gas.
 - b. Gas or vacuum system color code per NFPA 99 table 5.1.11

2.2 VALVE TAGS

- A. Plumbing Valve Tags Stamped or engraved numbers and letters (black-filled), 1-1/2 inch square with 1/2 inch numbers and 1/4 inch letters.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.
3. Example for identifying letter for various systems shall be as follows:
 - a. Cold Water = CW
 - b. Hot Water = HW
 - c. Hot Water Return = HWR
 - d. Trap Primer Water = TPW

B. Medical Gas Valve Tags Stamped or engraved numbers and letters (black-filled), 1-1/2 inch square with 1/2 inch numbers and 1/4 inch letters.

1. Medical gas valve tags shall be in accordance with the requirements of NFPA 99.
2. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Fasteners: Brass wire-link or beaded chain; or S-hook.
4. Medical gas valves shall be identified with name or chemical symbol for the specific medical gas or vacuum system, the room or area served and a warning to not open or close the valve except in emergency.
5. Example for identifying letter for various systems shall be as follows:
 - a. Medical Air = Med Air
 - b. Medical Vacuum = Med Vac
 - c. Oxygen = O2

C. Fastening shall be by brass "S" hooks, brass jack chains, or brass ball chains.

D. Manufacturer

1. Amico
2. Or Equivalent

2.3 VALVE SCHEDULES AND CHARTS

- A. Valve charts shall be of size sufficient to provide valve number, size, function, and location. Chart shall have key plan denoting approximate valve location.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.
 2. Valve-tag schedule(s) shall be mounted in locations to be directed by Owner. Mountings shall be in a metal frame with plexi-glass (clear) cover.
 3. Additionally, provide valve schedule in Excel Format.
- C. Valve charts shall be framed in wood or metal frames with Plexiglas cover.
- D. Charts and diagrams, (i.e., drawings, listing and valves) shall be provided in duplicate. Charts and lists shall include the following items:

1. Valve number.
2. Utility being transferred.
3. Valve location.
4. Area or equipment being serviced (example: AHU-G-4-101).

2.4 ZONE VALVE BOX LABELS

- A. Zone valve box labels shall be in accordance with the requirements of NFPA 99.
- B. Zone valve box labels shall be visible from outside the zone valve box assembly through the cover or be replicated on the outside. Label shall not be affixed to the removable cover.
- C. Labels for Medical Gas Zone Valve Box:
 1. Label Content:
 - a. Name of the gas or vacuum systems
 - b. Rooms or Areas served

2.5 MEDICAL EQUIPMENT NAME PLATES

- A. Medical Equipment name plates shall be in accordance with the requirements of NFPA 99.
- B. Heavy gauge (.025) aluminum with four mounting holes. Coloring in background, lettering, and pads in aluminum. Nameplates shall be located in an accessible and visible location.
- C. Labels for Medical Gas Source Equipment:
 1. Label Content:
 - a. Name of the gas or vacuum system
 - b. Gas or vacuum system color code
 - c. Rooms, Areas or Buildings served
 - d. Emergency contact information for the department or individual responsible for maintaining the equipment

2.6 CEILING MARKERS FOR CONCEALED EQUIPMENT, VALVES AND DEVICES

- A. Install color-coded ceiling markers on ceiling at concealed valve locations. Markers shall be a minimum of 7/8 inch diameter and shall include engraving to indicate service.
- B. Manufacturer and Model
 1. Seton – Style ECM
 2. Brady – Style ECM
 3. Bunting – Style ECM

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 PIPE IDENTIFICATION LABEL INSTALLATION

- A. Labels with flow directional arrows shall be installed on the piping such that they are clearly visible from the floor level.
- B. Labels on piping shall be at intervals of not more than 20 feet between labels. Or closer depending on obstacles. Additionally, labels shall be placed at all walls, floor and ceiling partitions.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Pipe identification shall be as follows:
 - 1. Piping shall have direction of flow arrows matching the legend and background colors adjacent to each marker and at branches.
 - 2. Pipe identification shall be placed on piping at 20-foot maximum intervals. In addition, wherever a pipe passes through a wall, floor, or ceiling, it should be identified on each side of the wall, floor, or ceiling.
 - 3. Where pipe insulation or pipe is to be painted, it should be painted to match the background color of its contents.
 - 4. Colors for pipe marking systems shall be in accordance with ANSI standards.

3.3 VALVE TAGS INSTALLATION

- A. Plumbing valves shall have brass tags indicating system and valve number.
- B. Provide valve charts in an approved location secured to wall.
- C. Include a copy of the valve chart in each operation and maintenance manual.
- D. All valves located above ceilings shall be marked on the ceiling with valve identification pins.

END OF SECTION 220553

SECTION 220593 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 QUALITY ASSURANCE

- A. Provide water systems balancing and testing by an approved member of a Certified Water Testing, Adjusting, and Balancing agency. The balancers must submit to the Architect a resume of experience, a sample of the forms to be used for the final report, and an inventory of the instruments to be used. Types, serial numbers and dates of last calibration of instruments used shall be listed in final balance reports.

1.3 WARRANTY

- A. Provide a guarantee on Testing and Balancing forms stating that testing and balancing will assist in completing requirements of the Contract Documents. Guarantee includes the following provisions:
 - 1. The certified Testing and Balancing firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

1.4 SUMMARY

- A. This section includes the following:
 - 1. Examination
 - 2. General requirements for testing and balancing
 - 3. Tolerances
 - 4. General requirements for medical gas systems
 - 5. Procedures for medical gas systems
 - 6. Field quality control of specialty items
 - 7. Adjustments
 - 8. Final inspection
 - 9. Final report

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper testing and balancing of systems and equipment.

- B. It shall be the Testing and Balancing firm's responsibility to review the drawings and to notify the Engineer if additional valves, test plugs, components, and associated appurtenances are required to properly balance the various systems prior to the installation of those systems. If the Testing and Balancing firm reviews the drawings and does not notify the Engineer that additional valves, test plugs, components, and associated appurtenances are required, then the Testing and Balancing firm shall be responsible to provide additional components, and associated appurtenances as required to properly balance the various systems at no additional cost to the Owner.
- C. Examine approved submittal data of systems and equipment.
- D. Examine system and equipment installations to verify that they are complete. Systems shall be cleaned, pressure tests completed and approved, and in continuous operation before balancing begins. Minimum continuous operation shall be 24 hours.
- E. Report deficiencies discovered before and during performance of testing and balancing procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 GENERAL REQUIREMENTS FOR TESTING AND BALANCING

- A. Provide complete testing and balancing of each and every water system and equipment that requires testing and balancing.
- B. Cut insulation, pipes and associated appurtenances for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed.
- C. Neatly mark equipment and balancing device settings with paint or other suitable, permanent identification material, including valve position indicators, and similar controls and devices, to show final settings.
- D. Coordinate with the General Contractor to ensure proper balancing above inaccessible ceilings before the ceilings are completed.
- E. Final tests and adjustments necessary to demonstrate compliance with specified performance requirements for major items of equipment shall be directly supervised by the manufacturer's representatives.
- F. The Architect shall be notified in writing of the date and time of final balancing and testing activities. Notification must be received at least 48 hours in advance so that the Architect can be present if he so wishes.

3.3 TOLERANCES

- A. Set water flow rates within the following tolerances where applicable:
 - 1. Hot Water Return Flow Rate: Minus 5 to plus 5 percent of design values.

3.4 GENERAL REQUIREMENTS FOR MEDICAL GAS SYSTEMS TESTING

- A. Provide complete testing of each medical gas system and equipment that requires testing and balancing per the requirements of NFPA 99.
- B. All systems that are breached and components that are subject to additions, renovations or replacement shall be inspected and tested.
- C. Systems shall be deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement or addition.
- D. Breached systems subject to inspection and testing shall be confined to only the specific altered zone and components in the immediate zone to the point of area of intrusion.
- E. Final tests and adjustments necessary to demonstrate compliance with specified performance requirements for major items of equipment shall be directly supervised by the manufacturer's representatives and .
- F. The Architect /Engineer shall be notified in writing of the date and time of final balancing and testing activities. Notification must be received at least 48 hours in advance so that the Architect / Engineer can be present.

3.5 MEDICAL GENERAL PROCEDURES

- A. Contractor shall perform all Installer-performed tests per the requirements of NFPA 99 5.1.12.2. Test shall include but not be limited to: Initial piping blowdown, Initial pressure test, Initial cross-connection test, Initial piping purge test, standing pressure test and standing vacuum test.
- B. The standing pressure test and the standing vacuum test shall be witnessed by a medical gas certified inspector or verifier and a form indicating the performance of the testing shall be provided to the medical gas system verifier of the project.
- C. It shall be the responsibility of the contractor to coordinate test periods with the medical gas system inspector or verifier prior to the start of the testing.
- D. Contractor shall coordinate the system inspections with the medical gas certified inspector or verifier per the requirements of NFPA 99 5.1.12.3.
- E. Contractor shall coordinate the system verification with the medical gas certified verifier per the requirements of NFPA 99 5.1.12.4.
- F. Copies of the medical gas system test and verification reports shall be provided to the client and architect / engineer for record.

3.6 FIELD QUALITY CONTROL OF SPECIALTY ITEMS

- A. Perform the following tests and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Test each of the above devices according to authorities having jurisdiction and the device's reference standard.

- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.7 ADJUSTMENTS

- A. Balance each balancing valve in accordance with the manufacturer's guidelines of installation, operation and maintenance to achieve optimum proper operating temperature and flow rates.
- B. Balance the domestic hot water system with the existing domestic hot water system for optimum proper operating temperatures and flow rates. Extreme care shall be exercised to avoid "short-cycling" of the hot water return system. balancing shall be repeated until the optimum results are achieved. Provide final report of the results.
- C. Provide an additional 25 hours for balancing after occupancy for additional adjustment.

3.8 FINAL INSPECTION

- A. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the Architect.
- B. Testing and Balancing firm test and balance engineer shall conduct the inspection in the presence of the Architect.
- C. The Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to 10 percent of the total measurements recorded.
- D. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- E. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- F. Testing and Balancing firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
- G. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another Testing and Balancing firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment to the HVAC Contract.

3.9 FINAL REPORT

- A. The Contractor shall obtain copies of the final Water Flow Balance and Test Reports from the balancing agency. Submit same to the Architect in accordance with the shop drawing submittal requirements for the Architect's evaluation and approval.

- B. The report shall be a typewritten or computer-generated printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- C. Include a certification sheet in front of binder signed and sealed by a Registered Professional Engineer.
- D. Include a list of instruments used for procedures, their serial numbers, and proof of calibration.

END OF SECTION 220593

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Mineral fiber.
 - 2. Insulating cements.
 - 3. Adhesives.
 - 4. Sealants.
 - 5. Factory-applied jackets.
 - 6. Field-applied jackets.
 - 7. Tapes.
 - 8. Securements.
 - 9. Corner angles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at pipe expansion joints for each type of insulation.
 - 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 4. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 5. Detail application of field-applied jackets.
 - 6. Detail field application for each equipment type.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- D. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000(Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- E. Mineral-Fiber and Pipe: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.

- d. Red Devil, Inc.; Celulon Ultra Clear.
- e. Speedline Corporation; Speedline Vinyl Adhesive.

2.3 SEALANTS

A. ASJ, All-Service-Jacket Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
- 5. Color: White.

2.4 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
- 2. Width: 3 inches.
- 3. Thickness: 11.5 mils.
- 4. Adhesion: 90 ounces force/inch in width.
- 5. Elongation: 2 percent.
- 6. Tensile Strength: 40 lbf/inch in width.
- 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
- 2. Width: 3 inches.
- 3. Thickness: 6.5 mils.
- 4. Adhesion: 90 ounces force/inch in width.
- 5. Elongation: 2 percent.
- 6. Tensile Strength: 40 lbf/inch in width.
- 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.5 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.
- Q. If existing and/or new piping, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

3.6 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are required, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, locations of threaded strainers, locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION

- A. Insulation type shall be Mineral-Fiber, Preformed fiberglass Pipe Insulation, Type I.
- B. Insulation Schedule Summary
 - 1. Cold water piping:
 - a. Piping \leq 1-1/4" insulation shall be 1/2" thick
 - b. Piping \geq 1-1/2" insulation shall be 1" thick
 - 2. Hot water and hot water return piping:
 - a. Piping \leq 1-1/4" insulation shall be 1" thick
 - b. Piping \geq 1-1/2" insulation shall be 1-1/2" thick
- C. Stormwater System:
 - 1. All Pipe Sizes: Insulation shall be provided on all horizontal stormwater piping to within 1 foot of vertical leader.
 - a. Mineral-Fiber, Preformed fiberglass Pipe Insulation, Type I: 1 inch thick.
 - b. Provide 1-inch-thick fiberglass insulation with vapor barrier on all horizontal storm piping to within 1 foot of vertical leader.
- D. Existing Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be of the following:
 - a. Mineral-Fiber, Preformed fiberglass Pipe Insulation, Type I: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
- F. Waste piping carrying A/C condensate drainage with water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be of the following:
 - a. Flexible Elastomeric closed-cell insulation: 1 inch thick.
- G. Floor Drains, Traps and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be of the following:
 - a. Mineral-Fiber, Preformed fiberglass Pipe Insulation, Type I: 1/2 inch thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Exposed:
 - 1. None.
 - 2. PVC: 20 mils thick.

END OF SECTION 220700

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

- A. Provide materials and installation procedures in conformance to all governing codes and the requirements of local authorities having jurisdiction.

1.3 PIPING SYSTEM STANDARDS OF MATERIALS

- A. Domestic water systems which connect to HVAC equipment, components, and associated appurtenances shall be terminated within five feet of final connection point with a shutoff valve and cap. Final connection to HVAC equipment, components, and associated appurtenances shall be provided under Division 23.
- B. Domestic water systems which connect to plumbing fixtures, equipment, components and associated appurtenances as indicated under another divisions drawings or specifications shall be provided with rough-in and final connection. Plumbing Contractor shall coordinate exact location of rough-in and make final connections.
- C. Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- D. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.

1.4 SUMMARY

- A. This section includes the following:
 - 1. Piping and fittings material
 - 2. Pipe joining materials
 - 3. Plumbing piping system pressure classification
 - 4. Encasement for piping.
 - 5. Transition fittings.
 - 6. Dielectric fittings.
 - 7. Flexible connectors.
 - 8. Beverage and soda dispenser supply piping
 - 9. Escutcheons.
 - 10. Sleeves
 - 11. Sleeve seals.
 - 12. Grout.
- B. Related Section:
 - 1. Division 22 Section "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.5 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Specialty valves.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Flexible connectors.
 - 5. Backflow preventers and vacuum breakers.
 - 6. Escutcheons.
 - 7. Sleeves and sleeve seals.
- B. Water Samples: Specified in "Cleaning" Article.
- C. Coordination Drawings: For piping in congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
 - 4. HVAC hydronic piping.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner no fewer than five days in advance of proposed interruption of water service.
 - 2. Do not proceed with interruption of water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS MATERIAL

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations and pipe sizes.
- B. Water systems shall be constructed of the following materials, subject to approval by authorities having jurisdiction.
- C. Copper piping and fittings
 - 1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.

- a. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
- b. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- c. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- d. Only Wrought-Copper shall be used for Braze-Joint Fittings: ASME B16.50, wrought-copper pressure fittings.
- e. Joining method: Solder Joint using 95/5 tin/antimony solder joint.
- f. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends
- g. Cut tube ends shall be reamed to the full inside diameter of the tube end.
- h. Joint surfaces shall be cleaned
- i. Manufacturers:

- 1) Piping - Cerro; Howell; Mueller
- 2) Fittings – Elkhart; NIBCO

2. Remarks: Provided in accordance with manufacturer requirements.
3. Piping 1/2" to 2" Solder Joint - Solder Filler Metals: ASTM B 32, lead-free alloys. 95/5 solder, include water-flushable flux according to ASTM B 813.
4. Piping 2-1/2" and above Braze Joint - Braze Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.2 PIPE JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. 95/5 solder, include water-flushable flux according to ASTM B 813.

2.3 PLUMBING PIPING SYSTEM PRESSURE CLASSIFICATION

- A. Piping, fittings, components, and equipment for the various plumbing piping systems shall meet the following pressure requirements:

Plumbing Piping System	Maximum Operating Pressure Range	Component Pressure Rating
Cold Water	80	125
Hot Water	80	125
Hot Water Return	80	125

2.4 TRANSITION FITTINGS

- A. General Requirements:
 1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dresser, Inc.; Dresser Piping Specialties.
 - b. Ford Meter Box Company, Inc. (The).
 - c. Romac Industries, Inc.
 - d. Smith-Blair, Inc; a Sensus company.
 - e. Viking Johnson; c/o Mueller Co.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure and temperature.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - b. Zurn Plumbing Products Group; Wilkins Water Control Products.
 2. Description:
 - a. Pressure Rating: 150 psig at 180 deg F.
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 2. Description:
 - a. Factory-fabricated, bolted, companion-flange assembly.
 - b. Pressure Rating: 300 psig minimum.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric Couplings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Calpico, Inc.
 - b. Lochinvar Corporation.
 2. Description:

- a. Galvanized-steel coupling.
- b. Pressure Rating: 300 psig at 225 deg F.
- c. End Connections: Female threaded.
- d. Lining: Inert and noncorrosive, thermoplastic.

E. Dielectric Nipples:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Precision Plumbing Products, Inc.
 - b. Victaulic Company.
- 2. Description:
 - a. Electroplated steel nipple complying with ASTM F 1545.
 - b. Pressure Rating: 300 psig End Connections: Male threaded or grooved.
 - c. Lining: Inert and noncorrosive, propylene.

2.6 FLEXIBLE CONNECTORS

- A. Where piping crosses over into an adjacent building that is installed with building expansion joint, depending on the system and the application, all piping crossing the two building separations shall be installed with copper flexible hose, stainless steel flexible hose, 3-Way Swing Joint or 3-Dimensional 'U' Joint.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mercer Rubber Co.
 - 2. Metraflex, Inc.
 - 3. Tozen Corporation.
 - 4. Universal Metal Hose; a Hyspan company
- C. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 - 1. Working-Pressure Rating: Minimum 250 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- D. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: Minimum 250 psig.
 - 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.7 BEVERAGE AND SODA DISPENSER SUPPLY PIPING

- A. The water supply piping from the backflow device to the beverage dispenser shall be acid-resistant. Copper piping shall not be used.

2.8 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.
- C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.
- E. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- F. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 GENERAL

- A. Lead content of water piping and fittings shall be equal to or less than 0.2 percent lead.
- B. Water distribution piping and fittings shall conform to NSF 61.
- C. Provide provision for expansion and contraction in the piping systems, to prevent undue stress or strain on piping, building anchor points and connected equipment.
- D. Piping connections to plumbing fixtures and equipment shall be provided with offsets, unions, and shutoff valves arranged such that equipment can be serviced or removed without dismantling the pipe.
- E. Branch connections to mains shall be made in such a manner as to prevent air trapping and prevent free passage of air.
- F. Converging or diverging Bullheaded Tee's are not permitted in piping systems.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B.
- C. Install shutoff valve immediately upstream of each dielectric fitting.
- D. Maintain velocities in the domestic water piping system as follows:

1. Cold water system, maximum 5 feet/second.
 2. Hot water system, maximum 5 feet/second.
 3. Minimum velocity of 4 feet/second shall be maintained.
- E. Install domestic water piping level and plumb.
- F. Rough-in, coordinate exact location and make final connections for the domestic water piping requirements provided from the equipment vendor for the following areas:
1. Medical Gas Fixtures and Equipment
 2. Medical Plumbing Fixtures and Equipment
 3. Any Other System Fixtures and Equipment Requiring Plumbing Systems
- G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. For domestic hot water systems equipped with recirculation systems, potable hot water distribution system shall be under constant recirculation to provide continuous hot water at each hot water outlet. Non-recirculated fixture branch piping shall not exceed the lengths specified in the International Energy Conservation Code-IECC, Table C404.5.1 Piping Volume and Maximum Piping Lengths.
- M. Do Not Install dead-end piping: Risers with no flow, branches with no fixtures shall not be permitted.
- N. In renovation projects, all dead-end piping shall be removed.
- O. All branches that are marked for removal shall be removed and reconnected back to an active line. Pressure piping shall have no capped piping such as a capped tee under any circumstance.
- P. All piping that are marked for removal shall be removed. Piping shall not be abandoned in place under any circumstance.
- Q. Install fittings for changes in direction and branch connections.
- R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S. Install thermometers in hot-water circulation piping. Comply with requirements in Division 22 Section "Meters and Gauges for Plumbing Piping" for thermometers.

- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gauges for Plumbing Piping" for thermometers.
- U. Do not install couplings within slab penetrations or sleeves.
- V. Install riser clamps for any location where the vertical stub is 24-inches in length or greater.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "Plumbing Valves" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller.
- C. Install drain valves at low points in horizontal piping and where required to drain water piping. Drain valves are specified in Division 22 Section Plumbing Valves".
 - 1. Hose-End Drain Valves: At low points in water mains and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install calibrated balancing valves in each hot-water circulation return branch. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.
- E. Provide test plugs or valved "Tee" ports located in strategic areas of the piping system to facilitate cleaning, disinfecting and flushing of the piping system.

3.5 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings.

3.7 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
- B. Install copper and/or bronze-hose flexible connectors in copper domestic water piping.
- C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 Section "Plumbing Hangers, Supports and Sleeves" for Plumbing Piping and Equipment installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Install hangers for copper piping with maximum permissible horizontal spacing and minimum rod diameters based on manufacturers data sheets.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install hangers for steel piping with maximum permissible horizontal spacing and minimum rod diameters based on manufacturers data sheets.

- G. Install supports for vertical steel piping every 15 feet.
- H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Plumbing Fixtures: Cold-water and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 "Plumbing Fixtures" Sections for connection sizes.
 - 2. Equipment: Cold-water and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.10 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
- C. Escutcheons for Existing Piping:
 - 1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
 - 2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.
 - 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
 - 4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.

3.11 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Valves shall be Lead Free. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.

2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.

B. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

C. Use check valves to maintain correct direction of domestic water flow to and from equipment.

3.12 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Testing Agency

1. Engage a qualified laboratory testing and inspecting agency to perform third party water tests, inspections, sampling and to submit final reports for quality of water.
2. Testing Agency shall report results of water tests and inspections, simultaneously in writing, to Owner, Architect, Contractor, Commissioning Agent, the local health department and authorities having jurisdiction within 48 hours of inspections and tests.
 - a. Test reports shall include reporting requirements of ASTM including the following as applicable to each test and inspection:
 - 1) Project name.
 - 2) Architect's Project Number.

- 3) Name of testing agency.
 - 4) Names and certification numbers of field and laboratory technicians performing inspections and testing.
 - 5) Name of Plumbing Contractor.
 - 6) Date and time of inspection, sampling, and field testing.
 - 7) Locations (Level, room and location) in work of where inspection occurred and / or samples were taken.
 - 8) Applicable standards
 - 9) Field test results.
- D. The entire hot water, hot water return and cold potable water systems shall be inspected for the following.
1. Cross connections between systems.
 2. Coloration of water.
 3. Presence of sediment.
 4. Detection of foul odors.
 5. Excessive entrapment or diffusion of water.
 6. Electrical shock.
- E. Water samples shall be taken from hot water, hot water return and cold water systems and submitted to an approved laboratory for routine bacteriological examination for each water system. In addition, a legionella test shall be performed on the hot water supply and return system and shall comply with AWWA C651 with test of 25 mg / 1 for 24 hours or ICC 651 with 50 mg / 1 for 24 hours for Species and Serogroup Legionella.
- F. Sample according to Authorities Having Jurisdiction Requirements, ASHRE 188 and ASTM at the following.
1. Sample process: Begin taking sample from the initial stream upon the turning on of the devices of each water system.
 - a. Remove cap and collect samples in biologically clean sample containers.
 - b. Avoid contamination from any source. Place lid on container immediately upon obtaining the sample.
 - c. Label each sample container with a unique sample number and project number, along with the date the sample was taken before taking the next sample.
 2. Sampling shall comply with the following:
 - a. Obtain samples after the respective water systems are balanced and hot water has been heated for a minimum of 24 hours.
 - b. Obtain samples after not less of 24 hours from the time when the disinfection and flushing of the system is complete.
 - c. Obtain samples not more than 21 days before beneficial occupancy.
 - d. Obtain samples from a minimum of one outlet per riser per floor. The overall minimum quantity of samples shall not be less than 10 samples.
 - e. Perform additional sampling when there appears to be any irregularities and more if a sample was compromised.

- f. Should any sample test fail, or should the sampling not comply with the requirements, the Architect and or Owner may require additional sampling, testing and reporting be performed at no cost to the Owner or Architect.
 - 3. Sample Storage and Transportation.
 - a. Keep samples between 40 deg F to 75 deg F.
 - b. Place samples in a covered and secured container.
 - c. Begin testing of samples within 24 hours from when the sample was taken unless required otherwise.
 - G. Piping Tests:
 - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 45 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours without loss in pressure. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
 - H. Domestic water piping will be considered defective if it does not pass tests and inspections.
 - I. All pipe and fittings shall be tested in accordance with local plumbing codes and regulations and with the manufacturer's requirements and recommendations.
 - J. Prepare test and inspection reports.
- 3.14 ADJUSTING
- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to proper flows.
 - 1) Remove plugs used during testing of piping and for temporary sealing of piping during installation.

- 2) Remove and clean strainer screens. Close drain valves and replace drain plugs.
- 3) Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
- 4) Check plumbing specialties and verify proper settings, adjustments, and operation.

3.15 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Remove aerators from all faucets prior to system flushing, cleaning and testing. Assure aerators are cleaned and reinstall when tests are completed in conformance with the above requirements and with Local Authorities Having Jurisdictions.
 - b. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - c. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for 3 hours.
 - d. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.16 ADJUSTING AND BALANCING

- A. After completion of the installations and prior to acceptance by the Owner, water systems and appurtenances shall be adjusted and balanced to deliver the water quantities indicated on the drawings, or as directed. Modify pumps and/or controls to produce design flow.
- B. Water circuits shall be adjusted by calibrated balancing valves provided as part of the installation, and calibrated balancing valves shall be permanently marked after final balance is complete so that they may be returned to their correct position if disturbed.
- C. Balance each balancing valve in accordance with the manufacturer's guidelines of installation, operation and maintenance to achieve proper operating temperature and flow rates.

- D. Balance the domestic hot water system for optimum proper operating temperatures and flow rates. Extreme care shall be exercised to avoid "short-cycling" of the hot water return system. Provide final report of the results.
- E. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

3.17 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs at ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Temperature-actuated water mixing valves.
 - 4. Strainers.
 - 5. Outlet boxes.
 - 6. Water hammer arresters.
 - 7. Trap-seal primer valves.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gauges for Plumbing Piping" for water meters, thermometers, thermowells, pressure gauges and test plugs.
 - 2. Division 22 Section "Domestic Water Piping" for water piping
 - 3. Division 22 Section "Emergency Plumbing Fixtures" for emergency safety equipment.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Spill-Resistant Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Size: As indicated on the drawings
5. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: As indicated on the drawings.
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Rough bronze.

B. Beverage-Dispensing-Equipment Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.

- b. Watts Industries, Inc.; Water Products Div.
 - c. Zurn Plumbing Products Group; Wilkins Div.
 - 3. Standard: ASSE 1022.
 - 4. Operation: Continuous-pressure applications.
 - 5. Size: NPS 1/4 or NPS 3/8.
 - 6. Body: Stainless steel.
 - 7. End Connections: Threaded.
 - 8. The water supply piping from the backflow device to the beverage dispenser shall be acid-resistant. Copper piping shall not be used.
- C. Dual-Check-Valve Backflow Preventers:
- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 3. Standard: ASSE 1024.
 - 4. Operation: Continuous-pressure applications.
 - 5. Size: As indicated on the drawings.
 - 6. Body: Bronze with union inlet.
- D. Hose-Connection Backflow Preventers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Woodford Manufacturing Company.
 - 2. Standard: ASSE 1052.
 - 3. Operation: Up to 10-foot head of water back pressure.
 - 4. Inlet Size: As indicated on the drawings.
 - 5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
 - 6. Capacity: At least 3-gpm flow.
- E. Backflow-Preventer Test Kits:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.

- c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
- 2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.
- F. Install appropriate type backflow preventers in each water supply to incoming water mains to the facility, mechanical equipment, systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

2.3 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Guardian Safety Equipment
 - b. Holby Valve Co., Inc
 - c. Lawler Manufacturing Company, Inc.
 - d. Leonard Valve Company.
 - e. Powers; a Watts Industries Co.
 - f. Symmons Industries, Inc.
 - g. Watts Industries, Inc.; Water Products Div.
 - h. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1017.
- 3. Pressure Rating: 125 psig.
- 4. Type: Thermostatically controlled water mixing valve.
- 5. Material: Bronze body with corrosion-resistant interior components.
- 6. Connections: Threaded union inlets and outlet.
- 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
- 8. Tempered-Water Setting: As indicated on the drawings.
- 9. Valve Finish: Rough bronze.

B. Individual-Fixture, Water Tempering Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lawler Manufacturing Company, Inc.
 - b. Leonard Valve Company.
 - c. Powers; a Watts Industries Co.
 - d. Symmons Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
- 2. The Following Standards Shall Apply as follows:
 - 1) ASSE 1016 : For use on individual bathtubs or showers.

- 2) ASSE 1069 : For use on skilled nursing area and on multiple showers. Does not allow user of the temperature adjustment.
 - 3) ASSE 1070 : For use on individual lavatories, hand sinks & public hand washing facilities.
 - 4) ASSE 1071 : For use on emergency eye wash, eye/face wash & emergency showers.
3. Thermostatically controlled water tempering valve.
 4. Pressure Rating: 125 psig minimum, unless otherwise indicated.
 5. Body: Bronze body with corrosion-resistant interior components.
 6. Temperature Control: Adjustable.
 7. Inlets and Outlet: Threaded.
 8. Finish: Rough or chrome-plated bronze.
 9. Tempered-Water Setting: 90 deg F.
 10. Tempered-Water Design Flow Rate: 0.5 gpm.

2.4 STRAINERS

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.033 inch.
 - b. Strainers NPS 2-1/2 to NPS 4 : 0.062 inch.
 - c. Strainers NPS 5 and Larger: 0.125 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.5 OUTLET BOXES

A. Ice Machine and Ice Maker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Oatey.
2. Mounting: Recessed.
3. Material and Finish: Stainless-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.
6. Provide in-line backflow preventer and in-line filter assembly with replaceable cartridge filter.

B. Dialysis outlet boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Guy Gray-IPS Corporation.
 - c. Willoughby Industries.
2. Mounting: Recessed.
3. Material and Finish: Stainless-steel type-316 box and satin finish faceplate.
4. Valves: PVC Ball valves with EPDM seals and O-rings.
5. Supplies: 1/2" Hot & cold supplies with 3/4" hose outlets.
6. Drain: 2" stainless steel tail-piece shall be connected directly to polypropylene drain line.
7. Box shall be equipped with door, wall anchor clips and lock with a key.

2.6 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Precision Plumbing Products - PPP, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products Inc.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Install water hammer arresters on all supply lines connected to flush valves.
3. Install water hammer arresters on all equipment with quick closing valves.
4. Standard: ASSE 1010 or PDI-WH 201.
5. Type: Copper tube with piston.
6. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.7 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.8 TRAP-SEAL PRIMER VALVES

A. Individual Trap Primers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018
3. Single Connection
4. Piping: NPS 1/2", ASTM B 88, Type L; copper, water tubing.
5. Provide trap primer with connection to Distribution Unit to provide trap seal for up to four drains.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install appropriate type backflow preventers in each water supply to incoming water mains to the facility, mechanical equipment, systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- E. Install balancing valves in locations where they can easily be adjusted.

- F. Install temperature-actuated water mixing valves with check stops and shutoff valves on inlet and outlet piping.
 - 1. Install thermometers and water regulators where specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- G. Install Y-pattern strainers for water on supply side of each control valve, solenoid valve, and pump.
- H. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- I. Install water hammer arresters in water piping according to PDI-WH 201.
- J. Install water hammer arresters on all supply lines connected to flush valves.
- K. Install water hammer arresters on all equipment with quick closing valves.
- L. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- M. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Flood protection control valves.
 - 4. Water pressure-reducing valves.
 - 5. Water control valves.
 - 6. Temperature-actuated water mixing valves.
 - 7. Strainers.
 - 8. Outlet boxes.
 - 9. Hose stations.
 - 10. Hose bibbs.

11. Wall hydrants or hose bibbs.
12. Non-Freeze ground hydrants.
13. Non-Freeze post hydrant.
14. Non-Freeze roof hydrant.
15. Water hammer arresters.
16. Air vents.
17. Trap-seal primer valves.
18. Trap Seal Primer Systems.
19. Water Treatment Systems.

- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Test each of the above devices according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Balance each balancing valve in accordance with the manufacturer's guidelines of installation, operation and maintenance to achieve proper operating temperature and flow rates.
- C. Balance the entire domestic hot water system for optimum proper operating temperatures and flow rates. Extreme care shall be exercised to avoid "short-cycling" of the hot water return system. Provide final report of the results.
- D. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

3.6 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs at ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221119

SECTION 221316 – SANITARY, WASTE, VENT AND STORM PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Sanitary and vent systems which are provided to serve HVAC equipment, components, and associated appurtenances shall be located within five feet of equipment drain point. Plumbing Contractor shall coordinate exact locations of HVAC drain points with Mechanical Contractor prior to rough-in of floor drains. HVAC drain piping, equipment, components, and associated appurtenances shall be provided under the Division 23.
- C. Each pipe length shall have the manufacturer's name cast, stamped, or rolled on.
- D. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped, or rolled on.
- E. All sanitary, waste, vent and storm piping intended for use in gravity systems shall only be used for gravity systems. Under No circumstances such piping shall be used for pressurized piping.

1.2 SCOPE OF WORK

- A. Provide materials and installation procedures in conformance to all governing codes and the requirements of local authorities having jurisdiction.

1.3 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Piping Materials - Pipe, tube and fittings.
 - 2. Plumbing piping system pressure classification
- B. Related Sections include the following:
 - 1. Division 22 Section "Sanitary Sewerage Pumps."
 - 2. Division 22 Section "Chemical Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.
 - 3. Comply with all requirements of Section 018113 – LEED Requirements.

1.4 DEFINITIONS

- A. General acronyms are listed below for general information. Not all acronyms are used in this text:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. BR: Butyl rubber.
 - 3. Buna-N: Nitrile rubber.
 - 4. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 5. CSM: Chlorosulfonyl-polyethylene rubber.
 - 6. EPDM: Ethylene-propylene-diene monomer rubber.
 - 7. LLDPE: Linear, low-density polyethylene plastic.

8. NBR: Acrylonitrile-butadiene rubber.
9. NR: Natural rubber.
10. PE: Polyethylene plastic.
11. PP: Polypropylene plastic.
12. PVC: Polyvinyl chloride plastic.
13. PVDF: PolyVinylidene Fluoride
14. TFE - Tetra-Fluoro Ethylene.

1.5 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 1. Sanitary, Waste, Vent and Storm Piping: 10-feet (4.3 PSI) head of water.
 2. Sanitary Sewer, Pumped Discharge or Force-Main Piping: 50 psig.

1.6 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings:
 1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
- C. Field quality-control inspection and test reports.

1.7 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.
- C. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.
- D. Protect all types of existing and new drains during construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS - PIPE, TUBE AND FITTINGS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:

a. Piping Manufacturers:

- 1) AB&I Foundry, Division of McWane Corporation
- 2) Charlotte Pipe and Foundry Company
- 3) Mueller Steamline Company
- 4) Tyler Pipe & Coupling, Division of McWane Corporation

b. Coupling Manufacturers:

- 1) ANACO-Husky
- 2) Clamp-All Corp.
- 3) Mission Rubber Company

2.3 SANITARY PIPING, SANITARY VENT PIPING AND STORM WATER PIPING - SERVICE WEIGHT HUBLESS (NO-HUB), CAST-IRON SOIL PIPE AND FITTINGS – ABOVE SLAB

- A. Pipe sizes: 2" and above.

- B. Pipe and Fittings: ASTM A 888 and CISPI 301 including Annex-A for third Party Certification.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: Conforming to ASTM A666 or CISPI 310 Type 304 extra heavy-duty corrugated stainless-steel shield at 0.015" thickness with Neoprene gasket conforming to ASTM C 564, stainless steel clamps and tightening devices. Shielding conforming to ASTM C 1277. Coupling shall be tested and certified to ASTM C 1540.
2. All stainless steel coupling sizes shall be with the following parameters:
 - a. 2"- 4" Pipe Sizes Shall be with 3" wide bands with 4-clamps @ 80 Lb-Ft torque.
 - b. 5"- 10" Pipe Sizes Shall be with 4" wide bands with 6-clamps @ 80 Lb-Ft torque.

2.4 SANITARY PIPING AND SANITARY VENT PIPING - COPPER PIPE AND FITTINGS

- A. Pipe material: Copper Type-DWV, conforming to ASTM-B 306 drawn temper Pipe

1. Pipe sizes: 1-1/4" - 2".
2. Fittings: Cast-Copper alloy conforming to ASME B16.23, or ASME B16.29, wrought copper.
3. Joining method: Solder Joint using 95/5 tin/antimony.

- B. Pipe material: Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

1. Pipe sizes: 1-1/4" - 2".

2. Fittings: Cast-Copper alloy conforming to ASME B16.18, cast copper or ASME B16.22, wrought copper.
3. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint ends.
4. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
5. Joining method: Solder Joint using 95/5 tin/antimony.

2.5 POLYPROPYLENE PIPE AND FITTINGS – FOR ACID WASTE AND VENT SYSTEM

A. ACID WASTE AND VENT PIPE AND FITTINGS – ABOVE SLAB IN NON-PLENUM RATED CEILINGS

1. Polypropylene Pipe Schedule 40 shall be joined by the coil heat fusion method. Pipe shall be manufactured of flame retardant homo-polymer polypropylene. Flammability requirements are based on ASTM D635 “Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position”.
2. Flame Retardant Polypropylene fittings shall be manufactured to Schedule 40 dimensions. Fittings shall be joined to the polypropylene pipe by means of coil heat fusion method. Fittings shall meet the same flammability requirements as described for pipe above.
3. All components of the system shall conform to the following applicable ASTM Standards, D4101, D3311, D1599, D2122, D2447, F1290 and F1412. All piping shall be marked with manufacturer's name, pipe size, schedule, type, quality control mark and ASTM information. All fittings shall be legibly marked showing manufacturer's trademark, fitting size, manufacturer's part number, and symbol indicating the material.

B. ACID WASTE AND VENT PIPE AND FITTINGS – IN RETURN AIR PLENUM RATED CEILINGS WITH HIGH TEMPERATURE DISCHARGE

1. Polyvinylidene (PVDF) Pipe Schedule 40 joined by the coil heat fusion method. Pipe shall be manufactured of flame retardant PVDF for service in plenum rated areas or high temperature to 280°F (138°C) flow stream. Flammability requirements are based on ASTM D635 “Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position”. The pipe must also meet or exceed ASTM E84 25/50 (UL 723) and UL 94-VO.
2. Flame Retardant Polyvinylidene (PVDF) fittings shall be manufactured to Schedule 40 dimensions. Fittings shall be joined to the PVDF pipe by means of coil heat fusion method. Fittings shall meet the same flammability requirements as described for pipe above.
3. All components of the system shall conform to the following applicable standards, ASTM E-84 25/50 (UL 723) and UL 94-VO. All pipes shall be marked with manufacturer's name, schedule, pipe size, ASTM-F1673, E-84, UPC, UL Classified date stamp and “Made In USA”. All fittings shall be legibly marked showing manufacturer's trademark, fitting size, manufacturer's part number, symbol indicating the material, ASTM F1673, UPC, USA.

C. MANUFACTURERS: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Georg Fischer - GF Piping Systems, LLC
2. IPEX Inc.
3. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
4. Town & County Plastics, Inc.
5. Watts Industries (Canada) Inc.
6. Zurn Plumbing Products Group; Chemical Drainage Systems Pipe and fittings in this Article are available in NPS 1-1/4 to NPS 6 (DN 32 to DN 150). Retain one or both of first two paragraphs below and coordinate with Part 3 "Piping Applications" Article.

- D. Installation of Polypropylene pipe and fittings shall be in accordance with local codes and regulations and with the manufacturer's requirements and guidelines.
- E. Mixing of various manufacturer of pipe and fittings shall not be permitted.
- F. Testing of Polypropylene pipe and fittings shall be tested in accordance with local plumbing codes and regulations and with the manufacturer's requirements and recommendations.
1. All sections of the piping system shall be tested with a maximum of 30 foot head of water (approximately 15 PSI) for heat fusion joint system.
 2. Joints may be pressure tested 10 minutes after heat fusion is completed.
 3. Under no circumstances should the piping system be tested with compressed air or any other type of gas.

2.6 PLUMBING PIPING SYSTEM PRESSURE CLASSIFICATION

- A. Piping, fittings, and components, for the sanitary and vent piping systems shall be capable of withstanding the following:

<u>Plumbing Piping System</u>	<u>Minimum Working Pressure</u>
Sanitary	10 Foot Head of Water
Sanitary Vent	10 Foot Head of Water
Storm Water	10 Foot Head of Water
Acid Waste	10 Foot Head of Water
Acid Waste Vent	10 Foot Head of Water

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide provision for expansion and contraction in piping systems to prevent undue stress or strain on piping, building anchor points, and connected equipment.

- B. Sanitary piping shall not be installed above any electrical rooms. If any sanitary piping is required to be installed in any of these areas, the sanitary piping shall be provided with a drain pan and leak detection system. An alternate to the drain pan, double wall containment piping may be provided at the Owner's discretion.
- C. Future connections or demolition of any part of a drainage or vent system shall be limited to a maximum of 24 inches from the active piping to which it connects.
- D. Horizontal branch piping that connects at the base of a stack, shall not be less than 10 times the diameter of the drainage stack. This distance shall be known as "Hydraulic Jump Zone". Fixtures and piping shall Not be permitted to discharge and connect in the Hydraulic Jump Zone area.
- E. Vent piping passing through roof construction shall be arranged to provide a minimum of 12 inch clearance from walls or other obstructions so as to permit proper flashing.
- F. Vent piping through roof shall extend a minimum of 12 inches above the roof, except where the roof is to be used for any purpose other than weather protection, the vent extension shall be a minimum of 7 feet above the roof.
- G. Vent piping shall not terminate directly beneath any door, operable window, or air intake opening of the building it serves or adjacent buildings.
- H. Vent piping shall be graded to drainage back to the drainage piping by gravity.
- I. Vent piping shall connect to horizontal drain piping shall connect above the centerline of the horizontal drain pipe.
- J. Vent piping shall rise vertically to a minimum of 6 inches above the flood level rim of the trapped fixture being vented prior to off-setting vertically.
- K. Connections to stacks or main drains shall be made in a manner that shall not permit backflow.
- L. Provide test tees in vertical risers as required to permit testing in sections.
- M. Prior to connecting to the existing sanitary piping system, clean out piping from the tie-in point to the next downstream cleanout. This shall not apply to new construction.
- N. Install all sanitary vents through roof away from all outside air intakes, windows and doors at a minimum of 25'-0".
- O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- P. Fitting Support Restraint: Horizontal pipe and fittings 4" and larger shall be restrained to prevent horizontal movement or fitting joint separation. The bracing shall be made at every branch opening, change in direction and at base of all risers. The restrained bracket shall be similar to Holdrite Series 117.

3.2 PIPING INSTALLATION

- A. Sanitary, waste and storm piping shall connect above the centerline of the street sanitary horizontal mains.

- B. Rough-in, coordinate exact location and make final connections for all piping requirements provided from the equipment vendor for the following areas:
 - 1. Medical Gas Fixtures and Equipment
 - 2. Medical Plumbing Fixtures and Equipment
 - 3. HVAC Fixtures and Equipment
 - 4. Any Other System Fixtures and Equipment Requiring Plumbing Systems
- C. Unless required by local authorities having jurisdiction or noted otherwise, provide 1 inch thick fiberglass insulation with vapor barrier on all horizontal storm piping to within 10 foot of vertical leader.

3.3 INSTALLATION AND TESTING

- A. Installation Procedures
 - 1. Floor cleanouts shall not be used except in locations where sanitary or storm water piping is under slab and wall cleanouts cannot be installed in an accessible location.
 - 2. Install cleanouts at base of all sanitary stacks where the slab is at grade.
 - 3. Install floor mounted rear discharge water closets with Combination Fitting, Long Sweep or similar connection for connection to the sanitary stack. Do not use Quarter Bend, Double Quarter Bend, Sanitary Tee or Sanitary Cross.
 - 4. Water closet cleanouts shall be 4" located above the flood rim level of the highest fixture served or a minimum of 36" above finish floor whichever is the greater. Cleanouts shall be provided with 12"x12" access door.
 - 5. Cleanout access doors shall be specified with a mill finish for field painting. Coordinate with General Contractor.
 - 6. Sanitary Horizontal drainage piping shall be installed in uniform alignment at uniform slopes. The minimum slope of horizontal sanitary drainage piping shall be as follows:
 - a. Sanitary piping 2-1/2 inches and smaller shall be sloped at a minimum pitch of 1/4 inch per foot (2 %).
 - b. Sanitary piping 3 inches to 6 inches shall be sloped at a minimum pitch of 1/8 inch per foot (1 %).
 - c. Sanitary piping 8 inches or larger shall be sloped at a minimum pitch of 1/16 inch per foot (1/2 %).
 - 7. Storm Horizontal drainage piping shall be installed in uniform alignment at uniform slopes. The minimum slope of horizontal storm drainage piping shall be as follows:
 - a. Storm piping where conditions permit slope may be 1/2 inch per foot (4 %).
 - b. Storm piping 3 inches & 4 inches shall be sloped at a minimum pitch of 1/4 inch per foot (2 %).
 - c. Storm piping 5 inches & 6 inches shall be sloped at a minimum pitch of 1/8 inch per foot (1 %).

- d. Storm piping 8 inches or larger shall be sloped at a minimum pitch of 1/16 inch per foot (1/2 %).
- 8. Branch drainage connections to stacks or main drains shall be made in a manner that shall not permit backflow.
- 9. When connecting to existing sanitary piping system, provide clean out piping from tie-in to the next downstream cleanout.
- 10. Do not install couplings within slab penetrations or sleeves.
- 11. Install riser clamps for any location where the vertical stub is 24-inches in length or greater.

B. System Testing

- 1. Drainage, waste, vent and storm piping
 - a. Cap all outlets and fill piping system to overflowing from a point at least 10 feet above the floor.
 - b. The water level shall remain constant throughout the test duration of 2 hours.
- 2. Provide test tees in vertical risers as required to permit testing in sections.
- 3. The piping systems shall be provided with two separate tests.
 - a. The first test shall occur during the installation
 - b. The final test shall occur after the plumbing fixtures have been set and their traps filled with water.
 - c. The piping systems shall be subjected to the final test in accordance with local ordinances
- 4. The piping systems tested during construction shall be provided by utilizing either water or air.
 - a. Water Test
 - 1) A water test shall be applied to each piping system either in its entirety or in sections. If applied to the entire system, openings in the piping system shall be tightly closed, except the highest opening, and the system shall be filled to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test. The section shall be filled with no less than a 10 feet head of water head.
 - 2) In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that no joint or pipe in the building, except for the uppermost 10 feet of the system, shall have been submitted to a test of not less than a 10 feet head of water head.
 - 3) The water shall be kept in the system, or in a portion under test, for at least 15 minutes before inspection starts.
 - b. Air Test
 - 1) Air test shall not apply to PVC or Plastic piping

- 2) An air test shall be applied to each system either in its entirety or in sections. Openings in the piping system shall be tightly closed and the system shall be filled with air until there is a uniform gauge pressure of 5 pounds per square inch or a pressure sufficient to balance a 10-inch column of mercury.
- 3) This pressure shall be held for a period of at least 15 minutes. Any adjustment to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period.

c. Final Test.

- 1) The final test shall be visual to determine compliance with the provisions of the plumbing code except that those systems shall be subject to a smoke test where necessary for cause.
- 2) Where a smoke test is utilized, it shall be made by filling traps with water and then introducing into the entire system a pungent, thick smoke produced by one or more smoke machines.
- 3) When smoke appears at the stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column shall be held for a test period of not less than 15 minutes.

END OF SECTION 221316

SECTION 221319 – SANITARY, WASTE, VENT AND STORM PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Through-penetration firestop assemblies.
- B. Comply with all requirements of Section 018113 – LEED Requirements

1.3 DEFINITIONS

- A. General acronyms are listed below for general information. Not all acronyms are used in this text:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. BR: Butyl rubber.
 - 3. Buna-N: Nitrile rubber.
 - 4. CR: Chlorosulfonated polyethylene synthetic rubber.
 - 5. CSM: Chlorosulfonyl-polyethylene rubber.
 - 6. EPDM: Ethylene-propylene-diene monomer rubber.
 - 7. LLDPE: Linear, low-density polyethylene plastic.
 - 8. NBR: Acrylonitrile-butadiene rubber.
 - 9. NR: Natural rubber.
 - 10. PE: Polyethylene plastic.
 - 11. PP: Polypropylene plastic.
 - 12. PVC: Polyvinyl chloride plastic.
 - 13. PVDF: PolyVinyliDene Fluoride
 - 14. TFE - Tetra-Fluoro Ethylene.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Floor drains.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.
- C. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith, Mfg. Co.
 - b. Josam Company; Blucher-Josam Div.
 - c. MIFAB, Inc.
 - d. Tyler Pipe & Coupling, Division of McWane Corporation
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group
- 2. Standard: ASME A112.36.2M for cast iron ASME A112.3.1 for stainless steel for cleanout test tee.
- 3. Size: Same as connected drainage piping
- 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch and Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk, brass cast-iron plastic plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

- 1. Provide square top cleanouts unless noted otherwise or requested by the Owner or the Architect.
- 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith, Mfg. Co.
 - b. Josam Company; Blucher-Josam Div.
 - c. MIFAB, Inc.

- d. Tyler Pipe & Coupling, Division of McWane Corporation
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group
- 3. Standard: ASME A112.36.2M for adjustable housing heavy-duty, adjustable housing cleanout.
 - 4. Size: Same as connected branch.
 - 5. Type: Adjustable housing heavy-duty, adjustable housing.
 - 6. Body or Ferrule: Cast iron.
 - 7. Clamping Device: Required.
 - 8. Outlet Connection: Threaded.
 - 9. Closure: Brass plug with tapered threads.
 - 10. Adjustable Housing Material: Cast iron with threads set-screws or other device.
 - 11. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
 - 12. Frame and Cover Shape: Round Square.
 - 13. Top Loading Classification: Extra Heavy Duty.
 - 14. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 - 15. Standard: ASME A112.3.1.
 - 16. Size: Same as connected branch.
 - 17. Housing: Stainless steel.
 - 18. Closure: Stainless steel with seal.
 - 19. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith, Mfg. Co.
 - b. Josam Company; Blucher-Josam Div.
 - c. MIFAB, Inc.
 - d. Tyler Pipe & Coupling, Division of McWane Corporation
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group
- 2. Standard: ASME A112.36.2M. Include wall access.
- 3. Size: Same as connected drainage piping.
- 4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk cast-iron plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 7. Wall Access: Round, deep, stainless-steel cover plate with screw.
- 8. Wall Access: Round, stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Corrosion resistant cast-Iron Floor Drains:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith, Mfg. Co.

- b. Josam Company; Blucher-Josam Div.
 - c. MIFAB, Inc.
 - d. Tyler Pipe & Coupling, Division of McWane Corporation
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group
- 2. Grates shall be ADA compliant and heelproof.
 - 3. Where the use of forklift trucks or trucks are used such as warehouses and loading docks, grates shall have H-20 rating and be of heavy-duty ductile iron type.
 - 4. Provide funnel where funnel floor drains are indicated on contract documents.
 - 5. Floor drains shall be as scheduled on the contract documents.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft, 0.0938-inch-thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

- 1. Open-Top Vent Cap: Without cap.
- 2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
- 3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.4 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L 51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

- 1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
- 2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
- 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

- 1. General Applications: 12 oz./sq. ft., 0.016-inch thickness.
- 2. Vent Pipe Flashing: 8 oz./sq. ft., 0.0106 thickness.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 0.0397-inch minimum thickness.

- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.
 - 1. Maximum Overcurrent Protection

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

- A. Through-Penetration Firestop Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
 - 2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
 - 3. Size: Same as connected soil, waste, or vent stack.
 - 4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - 5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 - 6. Special Coating: Corrosion resistant on interior of fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

- E. Provide waterproofing of floor drains and similar fixtures as required by local codes. Flashing material shall extend a minimum of 18 inches from the center of the floor drain in all directions.
- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- I. Install through-penetration firestop assemblies in plastic stacks at floor penetrations.
- J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- L. Install vent caps on each vent pipe passing through roof.
- M. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
- N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 224200 - PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General provisions of the Contract, Including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to plumbing fixture schedule on contract drawings for further details on plumbing fixtures, model names, model numbers, connection sizes and relevant information.

1.2 SCOPE OF WORK

- A. Provide materials and installation procedures in conformance to all governing codes and the requirements of local authorities having jurisdiction.

1.3 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Plumbing fixtures
 - 2. Plumbing fixture supply pipes
 - 3. Plumbing fixture supports
 - 4. Protective shielding guards
 - 5. Traps
- B. Comply with Americans with Disabilities Act (ADA) requirements where specialty plumbing fixtures are designated on the plans. Such fixtures shall be described with "ADA" designation and shall be installed in accordance with ADA guidelines.
- C. Related Sections include the following:
 - 1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
 - 2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains and specialty fixtures not included in this Section.
 - 3. Division 22 Section "Sanitary, Waste, Vent and Storm Piping Specialties" for floor drains, roof drains and specialty fixtures not included in this section.
 - 4. Division 22 Section "Emergency Plumbing Fixtures."

1.4 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered and used by people with disabilities.
- B. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- C. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

- D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- E. FRP: Fiberglass-reinforced plastic.
- F. PMMA: Polymethyl methacrylate (acrylic) plastic.
- G. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.5 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Power diagram, signal and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
3. Slip-Resistant Bathing Surfaces: ASTM F 462.
4. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
5. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
6. Vitreous-China Fixtures: ASME A112.19.2M.
7. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
8. Water-Closet, Flushometer Tank Trim: ASSE 1037.

1.7 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
- B. Warranty Period for Commercial Applications: One year(s) from date of Substantial Completion.

1.8 EXTRA MATERIALS

- A. Contractor shall be responsible for all quantities of all equipment, materials and all associated appurtenances used on the project.
- B. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 2. Flushometer Valve, Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than 12 of each type.
 3. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
 4. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. MANUFACTURERS

1. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Acorn Engineering Company
 - b. Advance Tabco

- c. American Standard Companies, Inc.
 - d. Aquarius Bathware
 - e. Belvedere Corporation
 - f. Bestbath Corporation
 - g. Bradley Corporation
 - h. Chicago Faucets – A Geberit Company
 - i. Delta Faucet Company
 - j. Elkay Manufacturing Company
 - k. Fiat Products – A Crane Plumbing Company
 - l. Florestone Products Company, Inc.
 - m. Jay R. Smith Manufacturing Company
 - n. Just Manufacturing Company
 - o. Kohler Company
 - p. Leonard Valve Company
 - q. Mansfield
 - r. Sloan Valve Company
 - s. Speakman Company
 - t. Symmons Industries, Inc.
 - u. T & S Brass and Bronze Works, Inc.
 - v. Toto USA
 - w. Waterbirth Solutions, Inc.
 - x. Whitehall Manufacturing
 - y. Zurn Industries, LLC
- B. For the basis of design and for a list of all plumbing fixtures used on this project, refer to plumbing fixture schedule on contract documents for further details on model names, model numbers, connection sizes and relevant information.
- C. Typical plumbing fixtures as listed below:
- 1. Clinical sinks
 - 2. Janitor's sinks
 - 3. Lavatories
 - 4. Sinks
 - 5. Mop receptors
 - 6. Showers
 - 7. Water closets
 - 8. Water coolers
- D. Americans with Disabilities Act (ADA) compliant fixtures.
- 1. Water closets shall measure 17-inches to 19-inches from finish floor to top of seat.
 - a. Manual flush valve handles for water closets shall be installed on the wide side of the stall.
 - 2. Wall hung lavatories shall be installed maximum of 34-inches above the finish floor.
 - a. Faucet handles shall be wrist blade or lever type and shall be operable with one hand.
 - b. Self-closing faucet valves shall remain open for minimum of 10 seconds.

c. Hot & cold-water supplies and waste piping and trap shall be insulated.

- E. All materials, installation procedures and selection of manufacturers of all Plumbing Systems used on this project shall be in accordance with Owner's and where applicable Tenant's Plumbing Design Guidelines and Standards. Consult the Owner, the Architect and the Engineer for further information. Acquire the approval of the Owner prior to final product purchase and installation.
- F. Tempered water shall be provided to all hand washing facilities through an approved water temperature limiting device conforming to ASSE 1070. Mixing valve shall be piped concealed below each individual lavatory and sink with an access panel.

2.2 PLUMBING FIXTURE SUPPLY PIPES

- A. Supply pipes for plumbing fixtures shall be with stainless steel flexible tubing, angle stop valves with loose key handles, cast brass escutcheon cover plate with set screw.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- a. McGuire – Model LFH2165LKCF
 - b. Zurn – Model ZH8822-XL-LRLK-PC-CE
 - c. Chicago Faucet – Model 1017-ABCP

2.3 PLUMBING FIXTURE SUPPORTS

- A. Provide plumbing fixture chair carrier supports for all wall hung fixtures. Chair carriers shall be supported at the base to the floor structure. Some fixture carriers may be supported directly from the wall with a specially designed wall bracket. Walls for such carriers shall be of concrete block or specifically designed and constructed stud construction for support of wall hung fixture.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Jay R. Smith, Mfg. Co.
 - 2. Josam Company; Blucher-Josam Div.
 - 3. MIFAB, Inc.
 - 4. Watts Drainage Products Inc.
 - 5. Zurn Plumbing Products Group

2.4 PROTECTIVE SHIELDING GUARDS

- A. Provide protective shielding pipe covers.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. McGuire Manufacturing Co., Inc.
 - 2. TRUEBRO, Inc.

- C. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.5 TRAPS

- A. Trap connection to the waste line from lavatories, sinks and similar wall mounted fixtures shall be with threaded nut and coupling. Do not solder trap connection to the waste piping.
- B. For sinks with 1-1/4 inch drain openings that are not provided with traps, provide an adjustable chrome-plated P-trap. P-Traps shall be 1-1/4 inch x 1-1/2 inch, 17 gauge tubing outlet with cleanout plug, set screw wall flange, and slip joint inlet.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGuire – Model 8902CF
 - 2. Zurn – Model Z8701-9B-PC-CE
 - 3. Watts – Model 519173R
- D. For sinks with 1-1/2 inch drain openings that are not provided with traps, provide an adjustable chrome-plated P-trap. P-Traps shall be 1-1/2 inch x 1-1/2 inch, 17 gauge tubing outlet with cleanout plug, set screw wall flange, and slip joint inlet.
- E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. McGuire – Model 8912C15F
 - 2. Zurn – Model Z8702-9B-PC-CE
 - 3. Watts – Model 51973
- F. Exposed piping, fittings, escutcheons, valves, etc. shall be chrome-plated brass.
- G. On existing floor drains where the area is not being renovated or the floor drain is to remain, provide trap seal protection device inside drain just below the grate. The device shall be ProSet, Trap Guard, TG-33 or equal. Trap Guard shall conform to ASSE 1072-07.

PART 3 - EXECUTION

3.1 GENERAL

- A. Do not scale drawings. Use architectural dimensioned drawings to locate plumbing fixtures.
- B. Provide plumbing fixtures in a secure, true, plumb and symmetrical manner. Thoroughly clean each fixture after installation and leave in proper working order, absolutely solid in their respective positions. For sinks and lavatories, verify clockwise rotation for cold water stem and counterclockwise rotation for hot water stem while facing respective stems.
- C. Water supply piping serving flush valves for water closets, urinals and associated accessories shall be securely anchored within the construction at each exit point to ensure that flush valves, equipment and accessories are absolutely rigid with no movement in supply pipes.

- D. When fixture trim is completed, adjust stops to provide proper flow through each valve or faucet.
- E. Each fixture shall be filled with water and checked for leaks and incorrect drainage.
- F. Flush valves, loose key or wheel handle stops, valves and similar devices shall be adjusted and balanced to provide first class operation of the various systems.
- G. Floor-mounted fixtures shall not be installed until finished floor is in place and ready for fixture installation.
- H. Where water closet or floor mounted fixture comes in contact with the floor, seal the base of the fixture with a non-shrink, mildew-resistant caulking.
- I. Where any plumbing fixture comes in contact with the wall, seal with a non-shrink, mildew-resistant caulking.
- J. Provide waterproofing of floor drains and similar fixtures as required by local codes. Flashing material shall extend a minimum of 18 inches from the center of the floor drain in all directions.
- K. Installation of handicapped plumbing fixtures shall meet requirements of Americans with Disabilities Act.
- L. Flush valves for handicapped water closets shall be provided on the transfer side of the water closet in accordance with ANSI 604.6.
- M. Provide final connection and install fixtures and equipment furnished by others.
- N. Provide D/C transformers as required to accommodate the requirements of electronic sensor operated faucets and flush valves. Refer to electrical drawings and specifications.
- O. Install floor mounted rear discharge water closets with Combination Fitting, Long Sweep or similar connection for connection to the sanitary stack. Do not use Quarter Bend, Double Quarter Bend, Sanitary Tee or Sanitary Cross.

END OF SECTION 224200

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- A. Refer to schedules on contract drawings for further details on plumbing fixtures, model names, model numbers, connection sizes and relevant information.

1.2 SCOPE OF WORK

- A. Provide materials and installation procedures in conformance to all governing codes and the requirements of local authorities having jurisdiction.

1.3 SUMMARY

- A. This Section includes the following emergency safety equipment:
 - 1. Emergency Drench Hose Equipment

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- C. Shop Drawings: Diagram power, signal, and control wiring.
- E. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data: For emergency plumbing fixtures to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act" ; and Public Law 101-336, "Americans with Disabilities Act" ; for plumbing fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.1 EMERGENCY SAFETY EQUIPMENT GENERAL REQUIREMENTS:

- A. All emergency equipment shall comply with American National Standards Institute/International Safety Equipment Association, ANSI/ISEA Z358.1 at the year as determined by local jurisdictions.
- B. Water temperature shall be Tepid and delivered between 60 deg F and 100 Deg F. It is possible that a chemical reaction might be accelerated by warm water, a medical professional shall be consulted to determine what would be the optimum water temperature.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Guardian Equipment Co.
 - 2. Haws Corporation
 - 3. Honeywell Safety and Productivity Solutions
 - 4. Speakman
 - 5. WaterSaver Faucet Co.
- D. For the basis of design and for a list of all emergency safety equipment and fixtures used on this project, refer to schedules on contract documents for further details on model names, model numbers, connection sizes and relevant information.

2.2 EMERGENCY SAFETY EQUIPMENT AS LISTED BELOW:

A. EMERGENCY DRENCH HOSE EQUIPMENT

- 1. Deliver potable water at a rate not less than 3.0 gpm for at least 15 minutes.
- 2. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
- 3. Control-Valve Actuator: Paddle.
- 4. Fixture shall include emergency mixing valve
- 5. Fixture shall include optional vacuum breaker.

2.3 EMERGENCY MIXING VALVE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Guardian Equipment Co.
 - 2. Haws Corporation
 - 3. Lawler
 - 4. Leonard Valve Co.
 - 5. Powers
 - 6. Speakman
- B. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

1. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure. Valve shall have adjustable temperature range of Minimum 60 deg F to Maximum 100 deg F. Valve shall conform to ASSE 1071.

2.4 SOURCE QUALITY CONTROL

- A. Certify performance of plumbed emergency plumbing fixtures by independent testing agency acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- E. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering (Mixing Valve) equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

3.3 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

3.4 ADJUSTING

- A. Adjust equipment temperature settings.

END OF SECTION 224500

SECTION 226219 – MEDICAL VACUUM PUMPS FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

- A. Provide materials and installation procedures in conformance to all governing codes and the requirements of local authorities having jurisdiction.

1.3 SUMMARY

- A. Section Includes:
 - 1. General Requirements for Packaged Medical Vacuum Pump Systems
 - 2. Medical vacuum equipment local alarm systems.

1.4 DEFINITIONS

- A. Standard Air - Measured in SCFM – Standard Cubic Feet/Minute, Flow rate of air under standard conditions at sea level
 - 1. Standard Air – Pressure 1 Atmosphere (29.92 in. Hg) before compression or expansion, Free Air at Temperature 68°F and Relative Humidity at 36%.
- B. Actual Air - Measured in ACFM – Actual Cubic Feet/Minute, Flow rate of compressed air delivered at compressor outlet.
- C. Medical Air Equipment: Compressed-Air equipment and accessories for healthcare facilities.
- D. Laboratory Air Equipment: Compressed-Air equipment and accessories for non-medical laboratory facilities.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- F. MGEM: Medical Gas Equipment Manufacturer

1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design medical vacuum equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Seismic Performance: Medical vacuum equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics and furnished specialties and accessories.
 1. Wiring Diagrams For: Power, signal and control wiring.
- B. Delegated-Design Submittal For: Medical vacuum equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of supports.
 2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- C. Qualification Data For: Qualified Installer and testing agency.
- D. Field quality-control reports.
- E. Operation and Maintenance Data For: Medical vacuum equipment to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
- B. Medical Air System Equipment for Healthcare Facilities: Qualify installers according to ASSE 6010.
- C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical vacuum equipment testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is a National Recognized Testing Laboratory - NRTL and that is acceptable to authorities having jurisdiction.
- D. Installing Contractor shall meet the certification qualifications of the following administered by Medical Gas Testing & Certification, LLC or Equivalent:
 - a. ASSE 6010 Medical Gas Systems Installer
 - b. ASSE 6020 Medical Gas Systems Inspector
 - c. ASSE 6030 Medical Gas Systems Verifier
 - d. ASSE 6040 Medical Gas Systems Maintenance Personnel
- E. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.
- F. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

- G. Comply with NFPA 99, "Health Care Facilities," for vacuum equipment and accessories for medical vacuum systems.
- H. Comply with UL 544, "Medical and Dental Equipment," for medical vacuum equipment.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Services: Do not interrupt services to the facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
- B. Notify the Architect, Construction Manager and the Owner no fewer than two days in advance of proposed interruption of service.
- C. Do not proceed with interruption of service without the Architect's, Construction Manager's and the Owner's written permission.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with the General Contractor for the equipment provided.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Vacuum Pump, Exhaust-Air Filter Elements: No fewer than two units.
 - 2. Belts: Two for each belt-driven pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. Being listed herein as an acceptable manufacturer does not permit the manufacturer to provide standard manufactured equipment that does not comply with the performance and/or physical-characteristic requirements of the Contract Documents.
- C. Where Water Cooled Systems will be employed, the system shall be provided with appropriately sized domestic cold water supply line, reduced pressure zone backflow preventer-RPZ and a drain line.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:
 - 1. Beacon-Medaes
 - 2. Allied Healthcare Products, Inc. Chemetron Division
 - 3. Amico Corporation

2.2 GENERAL REQUIREMENTS FOR PACKAGED MEDICAL VACUUM PUMP SYSTEMS

- A. Provide a complete medical vacuum source, complying with NFPA 99 5.1.3.7 in all respects, as specified and scheduled on the contract documents.
- B. All capacities shall be indicated in SCFM and the equipment shall deliver medical vacuum at 19-inches Hg.
- C. All components shall be at least duplexed and valved (or check valved as provided in NFPA-99) to permit service to any component without interrupting vacuum supply to the facility during any maintenance operation or any condition of single fault failure. Each pump exhaust shall be isolated by a ball valve for service isolation.
- D. Provide a complete medical vacuum plant consisting of pumps, receiver and controls capable of providing the scheduled capacity with one pump out of service and complying with requirements below.
- E. System shall be entirely on a single base or a base which can be separated in the field for rigging. If separable, bases are prepared for separation from the factory. System or system sections shall fit through a standard 36-inch door frame.
- F. System piping shall utilize O-ring sealed flanges and SAE O-ring or flare fittings for minimum leakage and easy repair. Valves shall be butterfly or ball type, positive seal with three-piece disassembly.
- G. System base, frames, control cabinet, piping and receiver shall be powder coated for durable and attractive finish.
- H. Flexible connections between pump units and the structure shall be provided. Each pump shall include corrugated metal inlet and outlet stainless steel flex connectors and shall be factory installed by the Medical Gas Equipment Manufacturer - MGEM. Systems employing plastic or rubber hoses for flex connectors shall not be acceptable.
- I. Provide liquid ring medical vacuum pumps. Internal construction shall be friction free and rotors shall be non-contacting. Each pump shall be water cooled and continuous duty rated. Pumps shall be equipped with high vacuum shutdown, high water level shutdown and high temperature shutdown.
- J. Each pump shall be direct or close coupled to a, NEMA-12 rated Premium Efficiency Totally Enclosed Fan Cooled - TEFC motor with a service factor of 1.15.
- K. Control system shall be contained in a rated cabinet factory pre-punched for conduit connections. Provide three punches: For power sized per NFPA 70 Article 310 and based on total system amperes, for communications and for master alarm wiring, each sized for ½" EMT conduit. The control system shall be built and labeled in a UL approved panel shop operating under ISO 13485 (Medical Device) registration. Provide in the control system door the following:
 - 1. Alarm lights associated with medical vacuum system alarms.
 - 2. Vacuum gauge and run time gauges.
 - 3. A separate disconnect handle with door interlock for each pump unit.
 - 4. Audio sounder capable of 80 dB at 3 feet with mute function provided by the controls.

5. Power on lamp illuminated whenever any disconnect is On.
6. Means for deactivating the screen saving function.

L. Provide in the control cabinet interior:

1. Full voltage motor starters with overload protection, one per pump.
2. Circuit breaker disconnects, one for each pump unit (note: for multiplex units greater than triplex, only two circuit breakers are required) operated by the through the door disconnect handle.
3. Redundant 24 Volt DC control circuit transformers including power seeking function in the event one power supply fails.
4. Power distribution terminal block convenient for main power entry.
5. All internal circuit boards and components needed for operation of the control system as described below.
6. Volt free contacts for connection to master alarms.
7. Controls circuitry shall be 24 Volts DC for worker safety. No system component other than the drive motors shall require greater than 24V for operation.

M. The control system shall provide for the following functionality:

1. Display of vacuum level on a single display for at a glance checking.
2. Automatic lead/lag sequencing and alternation. Display shall clearly show status of each pump including running unit, next-unit-in-sequence and units unavailable to run.
3. Runtime hour-meters for each pump unit.
4. In the event of control failure, the system shall activate all alarms and operate on a simple on/off basis until repaired.
5. When H-O-A selectors are in Hand mode, system shall operate on a vacuum switch and pump will not run if lead switch is satisfied.
6. Visual and audible alarm indication and isolated contacts for remote alarm for at least Lag Pump in Use.
7. Continuous monitoring of ambient temperature.
8. Automatic indication of major maintenance intervals and details of required maintenance kits.
9. Distinct separate indication on the control screens of alarms which shutdown the pump vs. alarms which do not shut down the pump vs. maintenance notifications.
10. Isolated contacts for remote alarms which can distinguish between a condition which shuts down the unit, A condition which does not shut down the system and a maintenance required event.
11. Control system shall permit individual test of lag in use, high temperature, and controls fault alarm points from the touchscreen. System shall include low level testing of controls, local, and connected master (source) alarms.
12. Controls shall facilitate one-person "bumping" of the pumps to test rotation.
13. Control system shall log and allow review of all alarm and shutdown events.
14. Control system shall be highly redundant and robust allowing for multiple failures before becoming unable to make vacuum. Control systems which can lose any single component and fail to make vacuum are not acceptable.
15. An integral webserver using standard Ethernet which facilitates observation of system operating parameters from any remote location on the same network with any standard web browser. Systems requiring special software are not acceptable.

16. Controls shall provide auto discovery from and of any Total Alert alarm on the same network allowing for system wide linking and inspection of any networked component through any single connection.
 17. BACnet capability. MGEM shall also be a registered BACnet vendor.
- N. The complete medical vacuum system and all electrical components shall be completely factory assembled and pre-tested prior to shipment by the Medical Gas Equipment Manufacturer - MGEM.
- O. Provide separately for installation at site in vacuum inlet piping, one (1) vacuum switch together with vacuum gauge and demand check. The switch shall be wired at site by others to Master Alarm Panels in two locations per NFPA 99 requirements.
- P. System Exhaust shall be through the roof with a minimum distance of 25 feet away from any outside air intake or openings such as windows and doors. Exhaust shall terminate minimum of 4'-0" above finish roof with a gooseneck and stainless steel screen secured with stainless steel bands.
- Q. The manufacturer shall supply the services of a factory-authorized technical representative to check the installation, start-up the vacuum system and instruct Owner's personnel in the operation and maintenance of the unit. A written report confirming that equipment was started and left in satisfactory operating condition shall be provided.
- R. The supplier shall have a fully staffed factory-authorized service organization available 24 hours a day, 7 days a week, year-round.
- S. The entire system shall be covered by factory warranty for 30 months from shipment.
- T. CAPACITIES AND CHARACTERISTICS:
1. Shall be as scheduled on the contract documents.

2.3 MEDICAL VACUUM AND WAGD EQUIPMENT ALARM SYSTEMS

- A. General Requirements for Medical Vacuum and WAGD Equipment Alarm System: Compatible alarm panels, remote sensing devices and other related components as required by NFPA 99 for Level 1 alarm systems. Refer to Division 22 Section "Medical Gas Piping for Healthcare Facilities" for medical vacuum piping systems. Power and alarm wiring as specified in Division 26 Sections. Coordinate with Electrical Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean medical vacuum equipment, accessories and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for medical vacuum applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
- B. Medical Vacuum Equipment Installation:
1. Install according to ASSE 6010 and NFPA 99.

2. Install medical vacuum equipment on concrete bases. Install units anchored to substrate in locations indicated. Maintain manufacturers' recommended clearances. Orient equipment so controls and devices are accessible for servicing.
 - a. Anchor equipment to concrete bases according to manufacturer's written instructions and seismic criteria applicable to Project.
 - 1) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 2) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.
 - 3) Install anchor bolts to elevations required for proper attachment to supported equipment.
 - b. Vibration Isolation: Install restrained-spring isolators. Vibration isolation devices and installation requirements are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - c. Vibration Isolation: Mount equipment on a vibration isolation equipment base as specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- C. At the receiver tank, provide drain leg and drain trap at low points.

3.2 MEDICAL VACUUM EQUIPMENT ALARM SYSTEM INSTALLATION

- A. Install medical vacuum equipment alarm system components in locations required by and according to NFPA 99.
- B. Install medical vacuum equipment local alarm panel as part of the system installation.

3.3 POWER REQUIREMENTS

- A. All equipment power source shall be from Essential Electrical System Emergency Power - Equipment Branch. Refer to electrical drawings.

3.4 CONNECTIONS

- A. Comply with requirements for drain piping specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings and specialties.
- B. Comply with requirements for medical gas piping for healthcare facilities specified in Division 22 Section "Compressed-Air Piping for Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.
- D. Connect medical vacuum piping to vacuum equipment, accessories and specialties with shutoff valve and union or flanged connection.

- E. Extend and connect all medical vacuum pump system's signals to Building Management System – BMS and existing Medical Master Alarm Panels. Provide all required wirings, supports and all associated appurtenances.

3.5 IDENTIFICATION

- A. Identify medical vacuum equipment system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment." and comply with NFPA 99.

3.6 FIELD QUALITY CONTROL FOR HEALTHCARE-FACILITY MEDICAL VACUUM EQUIPMENT

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections and to assist in testing.

3.7 TESTS AND INSPECTIONS:

- A. Medical Vacuum Equipment Testing Coordination: Perform tests, inspections, verifications and certification of medical vacuum equipment and piping concurrently with tests, inspections and certification of medical compressed air equipment and medical compressed air piping systems.
- B. Preparation: Perform medical vacuum equipment tests according to requirements in NFPA 99 for the following:
 - 1. System operation test.
- C. Equipment Verification: Comply with requirements in ASSE 6020, ASSE 6030, and NFPA 99 for verification of medical vacuum equipment.
- D. Replace damaged and malfunctioning controls and equipment.
- E. Testing Certification: Certify that specified tests, inspections and procedures have been performed and certify report results. Include the following:
 - 1. Inspections performed.
 - 2. Procedures, materials and gases used.
 - 3. Test methods used.
 - 4. Results of tests.
- F. Components will be considered defective if they do not pass tests and inspections. Repeat tests until the system passes the tests.
- G. Prepare and submit test and inspection reports.

3.8 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check belt drives for proper tension.
 - 3. Verify that vacuum and exhaust piping are clear.
 - 4. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
 - 5. Check safety valves for correct settings. Ensure that settings are higher than vacuum inlet pressure but not higher than rating of system components.
 - 6. Retain first subparagraph below if seismic restraints are specified.
 - 7. Check for proper seismic restraints.
 - 8. Drain receiver tank.
 - 9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 10. Test and adjust controls and safeties.
- B. Verify that Medical Vacuum equipment is installed and connected according to the Contract Documents and manufacturer's requirements.
- C. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in Division 26 Sections.
- D. Prepare written report documenting testing procedures and results.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain medical vacuum pump system and assemblies. Allot a minimum of 8hrs of training time for hospital maintenance staff.

END OF SECTION 226219

SECTION 226139 – MEDICAL GAS PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

- A. Provide materials and installation procedures in conformance to The Facility Guidelines Institute-FGI, NFPA-99 and the requirements of local authorities having jurisdiction.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Piping and fittings materials
 - 2. Pipe joining materials
 - 3. Medical gas service connections
 - 4. Sleeves
 - 5. Escutcheons
 - 6. Grout
- B. Related Sections include the following:
 - 1. Division 12 Section "Healthcare Casework" for gas outlets in metal medical casework.
 - 2. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment"
 - 3. Division 22 Section "Medical Gas Piping for Healthcare Facilities" for medical gas piping systems for healthcare facilities.

1.4 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. D.I.S.S.: Diameter Index Safety System.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Medical gas piping systems include the following non-flammable gas and vacuum for healthcare facility patient care applications.
 - 1. Oxygen
 - 2. Medical Air
 - 3. Medical Vacuum
 - 4. Waste Anesthetic Gas Disposal
 - 5. Nitrous Oxide
 - 6. Nitrogen
 - 7. Carbon Dioxide

1.5 PERFORMANCE REQUIREMENTS

- A. Medical gas systems shall be operating between the following pressure criterion:
 - 1. Oxygen – O₂: Piping and specialties designated “Medical Oxygen” operating at 50 to 55 psig (345 to 380 kPa).
 - 2. Medical Air – MA: Piping and specialties designated “Medical Air” operating at 50 to 55 psig (345 to 380 kPa).
 - 3. Medical Vacuum – MV: Piping and specialties designated “Medical Vacuum” operating between 17-inch Hg to 19-inch Hg (432 to 483 mmHg).
- B. Seismic Performance: Gas manifolds and piping shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.6 SUBMITTALS

- A. Product Data: For the following:
 - 1. Piping and fittings materials
 - 2. Pipe joining materials
 - 3. Valves and valve boxes
 - 4. Zone valves
 - 5. Outlets and inlets
 - 6. Patient service consoles
 - 7. Medical gas piping alarm systems
 - 8. Computer interface control panels
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds, gas cylinders, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- G. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
- H. Field quality-control test reports.

- I. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Professional Qualification Standard for Medical Gas Systems Installers:

1. The installation of the medical gas and vacuum systems shall be made by qualified, competent technicians who are experienced in performing such installations, including all personnel who actually install the piping system.
2. Prior to engaging work in Healthcare Facilities with any of the medical/surgical gas and vacuum systems, the medical gas Installers of Medical/Surgical Gas and Vacuum Piped distribution systems, all appurtenant piping supporting source gas manifold systems not including permanently installed bulk source systems, shall be certified in accordance with ASSE 6010. Installing Contractor shall meet the certification qualifications of the following administered by Medical Gas Testing & Certification, LLC or Equivalent:
 - a. ASSE 6010 Medical Gas Systems Installer
 - b. ASSE 6020 Medical Gas Systems Inspector
 - c. ASSE 6030 Medical Gas Systems Verifier
 - d. ASSE 6040 Medical Gas Systems Maintenance Personnel
3. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. NFPA Compliance:

1. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.

F. UL Compliance:

1. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
2. Comply with UL 544, "Medical Equipment," for medical gas specialties.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Services: Do not interrupt services to the facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify the Architect, Construction Manager and the Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without the Architect's, Construction Manager's and the Owner's written permission.
 - 3. Where Zone Valve Boxes-ZVB and Zone Alarm Panels-ZAP are installed in a fire rated partition, the ZVB and ZAP shall be provided with a fire rated enclosure. The enclosure shall be wrapped with the following products or equals to maintain the fire rating that matches the wall fire rating.
 - a. Manufacturer: STI - Thermal barrier wrap for membrane penetrations installation system no. W-I-7212
 - b. Manufacturer: Hilti - Firestop putty for pipe penetrations

1.9 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.
- B. Coordinate medical gas service connections with other service connections. Compressed-air service connections are specified in Division 22 Sections "Compressed-Air Piping for Healthcare Facilities" and "Vacuum Piping for Healthcare Facilities."
- C. Coordinate the location of all the following with the architectural drawings prior to rough-in and final connections:
 - 1. Medical gas zone valves
 - 2. Medical gas outlets and inlets
 - 3. Patient service consoles
 - 4. Local area zone alarm panel
 - 5. Medical gas zone and master alarm panels
 - 6. Computer interface control panel

1.10 EXTRA MATERIALS

- A. Contractor shall be responsible for all quantities of all equipment, materials and all associated appurtenances used on the project.
- B. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Quick-Coupler Service Connections: Furnish complete non-interchangeable medical gas pressure outlets and suction inlets for all gases equal to 10 percent of amount installed, but no fewer than 10 units.

2. D.I.S.S. Service Connections: Furnish complete non-interchangeable medical gas pressure outlets and suction inlets for all gases equal to 10 percent of amount installed, but no fewer than 10 units.
3. Vacuum bottle brackets: equal to 10 percent of amount installed, but no fewer than 10 units.
4. Contractor shall be responsible for confirming outlet works with wall thickness and providing extension pieces where required.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS MATERIALS

- A. Medical Gas piping refers to all of the medical gas systems described above; Medical Gas, Medical Vacuum and WAGD piping shall be of the following material:
- B. Medical Gas Piping: ASTM B 819, Type-K hard-drawn seamless, copper that has been manufactured cleaned, purged and sealed for medical gas service or according to CGA G-4.1 for medical gas service. Include standard color marking "OXY," "MED," "OXY/MED," in green for Type-K piping.
 1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1
 2. Medical Gas Piping Minimum pipe size shall be 1/2"
 3. Medical Vacuum Piping Minimum pipe size shall be 3/4" with a pitch of 1" in 50'-0"
 4. WAGD Piping Minimum pipe size shall be 3/4" with a pitch of 1" in 50'-0"
- C. Fittings: Wrought-Copper socket type pressure fitting conforming to ASME-B 16.50
- D. Joining method: Brazed joint conforming to ANSI/ASME-B 16.50
- E. Flux shall Not be used.
- F. Cast copper alloy fittings shall not be permitted.
- G. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Smart Technology, Inc. (Smart Tap).
- H. Manufacturers:
 1. Piping - Cerro; Howell; Mueller
 2. Fittings – Elkhart; NIBCO

2.2 PIPE JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated. Joints shall be made using brazing alloy with melting temperature in excess of 1000°F (538°C).
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.3 MEDICAL GAS SERVICE CONNECTIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Healthcare Products, Inc.; Chemetron Div.
 - 2. Amico Corporation
 - 3. Beacon-Medaes.
 - 4. Tri-Tech Medical
- B. Connection Devices: For specific medical service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 1. Roughing-in Assembly:
 - a. Steel outlet box for recessed mounting and concealed piping.
 - b. Brass-body inlet block.
 - c. Seals that will prevent leakage.
 - d. ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
 - 2. Finishing Assembly:
 - a. Brass housing with primary check valve.
 - b. Seals that will prevent leakage.
 - c. Cover plate with gas-service label.
 - 3. Quick-Coupler Service Connections: Suction inlets for medical service outlets with non-interchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
 - 4. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
 - 5. Cover Plates: One-piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.4 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

- A. Drain Piping: Use the following piping materials:
 - 1. Copper water tube, cast- or wrought-copper fittings, and soldered press-type fittings, and pressure-sealed joints.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of medical piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Comply with ASSE Standard #6010 for installation of medical piping.
- C. The installation of Medical Gas Piping shall be prohibited from the following locations weather specifically mentioned or not:
 - 1. Areas with Open Flames
 - 2. Areas where piping is subjected to contact with Fuel, Oil, etc.
 - 3. Electrical Closets
 - 4. Electrical Service Equipment Rooms
 - 5. Elevator Machine Rooms
 - 6. Elevator Shafts
 - 7. Fire Pump Rooms

8. Incinerator Rooms
 9. Kitchens
 10. Laundry Rooms
 11. Stairwells
-
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
 - E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
 - G. Install piping adjacent to equipment and specialties to allow service and maintenance.
 - H. Install medical and drain piping with 1 percent slope downward in direction of flow.
 - I. Install nipples, unions, and special fittings and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
 - J. Install eccentric reducers, if available, where medical piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
 - K. Install gauges on inlet piping to each medical gas and medical vacuum producer and on each receiver and separator. Comply with requirements in Division 22 Section "Meters and Gauges for Plumbing Piping."
 - L. Install piping to permit valve servicing. Provide access panels where required in areas with hard ceiling.
 - M. Install piping free of sags and bends.
 - N. Under no circumstances the medical gas and medical vacuum piping shall be installed vertically in "U" configuration around any obstacles, Such as, ductwork, beams, equipment and alike. The "U" installation practice will create traps and dead legs in the piping system. It increases the friction losses and impedes on the proper functionality of the piping system. The "U" configuration may be installed in a horizontal position only.
 - O. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
 - P. Install medical piping to medical piping service connections specified in this Section and to equipment specified in other Sections requiring medical piping service.
 - Q. Install seismic restraints on medical piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - R. Install medical piping service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

- S. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
- T. Connect medical piping to medical gas producers and to equipment requiring medical gas service.
- U. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE APPLICATIONS

- A. Valves for Copper Piping: Use copper alloy ball and bronze check types.

3.5 VALVE INSTALLATION

- A. Install shutoff valve at each connection to and from medical equipment and specialties.
- B. Install check valves to maintain correct direction of medical gas flow to medical gas and medical vacuum-producing equipment.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install safety valves on receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
- F. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.
- G. Install flexible pipe connectors in suction inlet piping to each medical air and vacuum producing equipment.
- H. Lock All Medical Gas Maintenance valves in open position. Provide two sets of lock keys to facilities management.

3.6 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Shall not be used.
- E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- F. Soldered Joints: Shall not be used.

G. Flux: Shall not be used.

H. Flanged Joints:

1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

3.7 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

- A. Panels for medical piping systems may be combined in single panels unless otherwise noted.
- B. Install medical gas piping alarm system components; wiring, conduits, etc. in locations required and in accordance with NFPA 99.
- C. Install medical piping system area and master alarm panels where indicated on the drawings.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- B. Vertical Piping: MSS Type 8 or 42, clamps.
- C. Individual, Straight, Horizontal Piping Runs:
 1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
 2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
- D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- E. Base of Vertical Piping: MSS Type 52, spring hangers.
- F. Support horizontal piping within 12 inches of each fitting and coupling.
- G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1/4: 60 inches with 3/8-inch rod.
 2. NPS 3/8: 72 inches with 3/8-inch rod.
 3. NPS 1/2: 72 inches with 3/8-inch rod.
 4. NPS 3/4: 84 inches with 3/8-inch rod.
 5. NPS 1: 96 inches with 3/8-inch rod.
 6. NPS 1-1/4: 108 inches with 3/8-inch rod.
 7. NPS 1-1/2: 10 feet with 3/8-inch rod.
 8. NPS 2: 11 feet with 3/8-inch rod.
 9. NPS 2-1/2: 13 feet with 1/2-inch rod.
 10. NPS 3: 14 feet with 1/2-inch rod.
 11. NPS 4: 16 feet with 1/2-inch rod.

12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

- I. Install supports for vertical copper tubing every 10 feet.

3.9 LABELING AND IDENTIFICATION

- A. Install identifying labels and devices with flow directional arrows for medical gas piping, valves and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."
- B. Install identifying labels and devices for medical gas piping systems according to NFPA 99. Unless required by the facility standards use the following or similar captions and color-coding for piping products where required by NFPA 99.

1. Oxygen Piping:

- a. Background Color: Green/White
- b. Letter Color: White/Green

2. Medical Air Piping:

- a. Background Color: Yellow
- b. Letter Color: Black

3. Medical Vacuum Piping:

- a. Background Color: White
- b. Letter Color: Black

3.10 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL PIPING

- A. Test and certify the entire new medical gas system and where the new system impacts the existing system.
- B. Test and certify the medical gas system downstream of any existing valve that was shut down for the connection of the new piping to the existing system. This shall only occur if the existing shut-off valve is tested for zero flow after shut down.
- C. Where new piping connections are made to the existing piping and there are no existing valves present, the entire piping system shall be tested and certified unless "Smart Tap" system is employed to make the pipe connection. In this situation, test and certify the piping system downstream of the "Smart Tap" connection.
- F. Perform tests and inspections of medical piping systems in healthcare facilities and prepare test reports.
- H. Tests and Inspections:

1. Medical piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
2. Provide valved "Tee" ports located in strategic areas of the piping system to facilitate cleaning, purging and testing of the piping system. Follow all criterion of NFPA 99 and all other National and Local guidelines and regulations.
3. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blow down.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for medical gas piping systems.
 - f. Repair leaks and retest until no leaks exist.
4. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical piping systems and perform the following tests and inspections:
 - a. Standing pressure test.
 - b. Individual-pressurization cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Final tie-in test.
 - g. Operational medical piping test.
 - h. Verify correct labeling of equipment and components.
5. Testing Certification: Certify that specified tests, inspections and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials and gases used.
 - c. Test methods used.
 - d. Results of tests.

- I. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.11 DEMONSTRATION

- A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 226139

SECTION 226149 – MEDICAL GAS PIPING SPECIALTIES FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK

- A. Provide materials and installation procedures in conformance to The Facility Guidelines Institute-FGI, NFPA-99 and the requirements of local authorities having jurisdiction.

1.3 SUMMARY

- A. This Section includes the following:
 - 1. Medical Gas Valves
 - 2. Medical gas zone valves and zone valve boxes
 - 3. Medical gas outlets and inlets
 - 4. Medical gas piping alarm system
 - 5. Local area zone alarm panel
 - 6. Medical gas zone and master alarm panels
 - 7. Computer interface control panel
- B. Related Sections include the following:
 - 1. Division 12 Section "Healthcare Casework" for gas outlets in metal medical casework.
 - 2. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment"
 - 3. Division 22 Section "Medical Gas Piping for Healthcare Facilities" for medical gas piping systems for healthcare facilities.

1.4 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. D.I.S.S.: Diameter Index Safety System.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Medical gas piping systems include the following non-flammable gas and vacuum for healthcare facility patient care applications.
 - 1. Oxygen
 - 2. Medical Air
 - 3. Medical Vacuum
 - 4. Waste Anesthetic Gas Disposal
 - 5. Nitrous Oxide
 - 6. Nitrogen
 - 7. Carbon Dioxide

1.5 PERFORMANCE REQUIREMENTS

- A. Medical gas systems shall be operating between the following pressure criterion:
 - 1. Oxygen – O₂: Piping and specialties designated “Medical Oxygen” operating at 50 to 55 psig (345 to 380 kPa).
 - 2. Medical Air – MA: Piping and specialties designated “Medical Air” operating at 50 to 55 psig (345 to 380 kPa).
 - 3. Medical Vacuum – MV: Piping and specialties designated “Medical Vacuum” operating between 17-inch Hg to 19-inch Hg (432 to 483 mmHg).
- B. Seismic Performance: Gas manifolds and piping shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.6 SUBMITTALS

- A. Product Data: For the following:
 - 1. Piping and fittings materials
 - 2. Pipe joining materials
 - 3. Valves and valve boxes
 - 4. Zone valves
 - 5. Outlets and inlets
 - 6. Medical gas piping alarm systems
 - 7. Computer interface control panels
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
- D. Qualification Data: For Installer and testing agency.
- E. Brazing certificates.
- F. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds, gas cylinders, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- G. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
- H. Field quality-control test reports.

- I. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Professional Qualification Standard for Medical Gas Systems Installers:

1. The installation of the medical gas and vacuum systems shall be made by qualified, competent technicians who are experienced in performing such installations, including all personnel who actually install the piping system.
2. Prior to engaging work in Healthcare Facilities with any of the medical/surgical gas and vacuum systems, the medical gas Installers of Medical/Surgical Gas and Vacuum Piped distribution systems, all appurtenant piping supporting source gas manifold systems not including permanently installed bulk source systems, shall be certified in accordance with ASSE 6010. Installing Contractor shall meet the certification qualifications of the following administered by Medical Gas Testing & Certification, LLC or Equivalent:
 - a. ASSE 6010 Medical Gas Systems Installer
 - b. ASSE 6020 Medical Gas Systems Inspector
 - c. ASSE 6030 Medical Gas Systems Verifier
 - d. ASSE 6040 Medical Gas Systems Maintenance Personnel
3. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. NFPA Compliance:

1. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.

F. UL Compliance:

1. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
2. Comply with UL 544, "Medical Equipment," for medical gas specialties.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Services: Do not interrupt services to the facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify the Architect, Construction Manager and the Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without the Architect's, Construction Manager's and the Owner's written permission.

1.9 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.
- B. Coordinate medical gas service connections with other service connections. Compressed-air service connections are specified in Division 22 Sections "Compressed-Air Piping for Healthcare Facilities" and "Vacuum Piping for Healthcare Facilities."
- C. Coordinate the location of all the following with the architectural drawings prior to rough-in and final connections:
 - 1. Medical gas zone valves
 - 2. Medical gas outlets and inlets
 - 3. Local area zone alarm panel
 - 4. Medical gas zone and master alarm panels
 - 5. Computer interface control panel

1.10 EXTRA MATERIALS

- A. Contractor shall be responsible for all quantities of all equipment, materials and all associated appurtenances used on the project.
- B. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Quick-Coupler Service Connections: Furnish complete non-interchangeable medical gas pressure outlets and suction inlets for all gases equal to 10 percent of amount installed, but no fewer than 10 units.
 - 2. D.I.S.S. Service Connections: Furnish complete non-interchangeable medical gas pressure outlets and suction inlets for all gases equal to 10 percent of amount installed, but no fewer than 10 units.
 - 3. Vacuum bottle brackets: equal to 10 percent of amount installed, but no fewer than 10 units.
 - 4. Contractor shall be responsible for confirming outlet works with wall thickness and providing extension pieces where required.

PART 2 - PRODUCTS

2.1 MEDICAL GAS VALVES

A. Medical Gas Valves

1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
 - a. Exception: Factory cleaning and bagging are not required for valves for WAGD service.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation
 - c. Beacon-Medaes.
 - d. Tri-Tech Medical
3. All Medical Gas Valves shall be Manufacturer cleaned, purged and bagged specially prepared for oxygen service and shall conform to NFPA 99. Valves shall be bronze three-piece ball-type, with Teflon seats and adjusting stem packing gland with Teflon stem seal.
4. Valve types shall be three-piece construction with swing out center.
5. Valve ends where copper to brass joint is made shall be forged, complying with NFPA-99. Cast valves are not acceptable.
6. Pressure Rating: 300 psig minimum.
7. Ball: Full-port.
8. Seats: PTFE or TFE.
10. Handle: Lever type with locking device.
11. Stem: Blowout proof with PTFE or TFE seal.
12. Ends: Manufacturer-installed ASTM B 819, Type K copper tubing extensions.
13. Seals between center section and outer flanges shall be silicone, capable of withstanding 500°F (260°C) during the brazing process.
14. Ball valves shall be rated 600 WOG, actuate from full "ON" to full "OFF" by 90 degree turn of vinyl gripped valve handle.
15. Valves not in valve boxes shall be provided with locking handles.
16. All valves shall be cleaned for oxygen, capped and sealed in a polyethylene bag for shipping and storage.

B. Bronze Check Valves: In-line pattern.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation
 - c. Beacon-Medaes.
 - d. Tri-Tech Medical
2. Pressure Rating: 300 psig minimum.

3. Operation: Spring loaded.
 4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- C. Outdoor Use Ball Valve: 3-piece-body, bronze ball valve, full port, teflon seat, stainless steel ball & stem, 6" extended cup (extension inlets) with 316 stainless steel exterior trim, nuts, bolts and handle.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valve Company
 - b. Conbraco Industries, inc.
 - c. Hammond Valve
 - d. Jomar Valve, Inc.
 - e. Milwaukee Valve Company
 - f. Nibco Valve Company
 2. Pressure Rating: 600 psig cold working pressure, 200 psig for Medical Gas
 3. Ball: Full-port.
 4. Seats: PTFE or TFE.
 5. Handle: Lever type with locking device.
 6. Stem: Blowout-proof with PTFE or TFE seal.
 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

2.2 MEDICAL GAS ZONE VALVES AND ZONE VALVE BOXES

- A. 3-piece-body, bronze ball valve with gage.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Healthcare Products, Inc.; Chemetron Div.
 - b. Amico Corporation
 - c. Beacon-Medaes.
 - d. Tri-Tech Medical
 2. Pressure Rating: 300 psig minimum.
 3. Ball: Full-port.
 4. Seats: PTFE or TFE.
 5. Handle: Lever type with locking device.
 6. Stem: Blowout proof with PTFE or TFE seal.
 7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 8. Medical Gas Gage: Manufacturer installed on one copper-tube extension.
- B. Medical Gas Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection and of size for single or multiple valves with gages and in sizes required to permit manual operation of valves.
1. Interior Finish: Factory-applied white enamel.
 2. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.

3. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
4. Zone Valve boxes shall be constructed of 18 gauge steel with white enamel finish. The valve box shall have a sliding, opaque door with pull ring and clear gauge window. The removable window cannot be replaced when any valve is closed. The assembly shall be capable of adjusting for variances in wall thickness from 3/8" to 1-1/2". The window shall conceal piping and mounting screws. Window shall be labeled "Caution - Medical Gas Shut - Off Valves - Close Only in Emergency." Provide clear viewing space in the window to display the gas service, the pressure gauges and the label for areas controlled by the valve.
5. Provide color coded self-adhesive gas labels for compliance with NFPA 99 labeling requirements. Apply labels to each valve in the assembly for gas service identification according to manufactures recommendations.
6. Zone valves shall include a 1-1/2 inch pressure gauge reading 0 to 100 psig for oxygen, air, nitrous oxide and carbon dioxide; 0 to 300 psig for nitrogen and instrument air; and 0 to 30 HG for vacuum and WAGD. The gauge port shall be equipped with removable plug for pressure testing before final assembly of gauge.
7. All zone valve boxes assemblies shall read pressure downstream and vacuum upstream of the valve per NFPA 99. Horizontal valves shall be piped left to right with right being on patient side.
8. All main line, riser, service and futures valves as scheduled on the drawings shall include plugged 1/8" NPTF ports on inlet and outlet.
9. All zone valve assemblies shall have a total of three 1/8" NPT ports with plugs. One port to be used as a provision for connection of a gauge and shall be located on the terminal outlet side of the valve to register pipeline pressure or vacuum. The second port to be used as a provision for a DISS connection of a gas sensor. The third port to be used for purging during the brazing process and is located upstream of the valve.
10. Horizontal zone valve assembly designs allow for the configuration of up to 7 valves within the rough-in box assembly. Vertical zone valve assembly designs allow for the configuration of up to 4 valves within the rough-in box assembly.
11. Where vertical zone valve assemblies are shown on the plans, horizontal assemblies shall not be acceptable.
12. All zone valve box assemblies to include Nylon 6/6 insulated grommets to allow for ease of valve replacement and reorientation within the rough-in box.
13. All zone valve box doors to be treated with InstaCure Guardian to reduce/prevent bacterial and mold growth.
14. Provide alarm sensor kit, which facilitates area alarm sensor installation inside the zone valve box. Provide this part where alarm sensors are shown at this location on the plans.
15. Where Zone Valve Boxes-ZVB and Zone Alarm Panels-ZAP are installed in a fire rated partition, the ZVB and ZAP shall be provided with a fire rated enclosure. The enclosure shall be wrapped with the following products or equals to maintain the fire rating that matches the wall fire rating.
 - a. Manufacturer: STI - Thermal barrier wrap for membrane penetrations installation system no. W-I-7212
 - b. Manufacturer: Hilti - Firestop putty for pipe penetrations

2.3 MEDICAL GAS PIPING ALARM SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Healthcare Products, Inc.; Chemetron Div.
 2. Amico Corporation
 3. Beacon-Medaes.
 4. Tri-Tech Medical
- B. Panels for medical piping systems may be combined in single panels with medical gas piping systems.
- D. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
- E. Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
1. Operating Range: 0- to 100-psig. (0- to 690-kPa). For Oxygen, Medical Air, Nitrous Oxide and Carbon Dioxide.
 2. Operating Range: 0- to 300-psig. (0- to 1380-kPa). For Nitrogen.
 3. Operating Range: 0- to 30-in. Hg. (0- to 760-mmHg).
- F. Equipment System Supply Line.
1. Provide pressure switch with quick connect and gas specific demand check valve with D.I.S.S connection. Extend signals to the Master Alarm Panels
 2. Provide pressure gauge with quick connect and gas specific demand check valve with D.I.S.S connection.

2.4 LOCAL AREA ZONE ALARM PANEL

- A. Provide remote digital pressure sensors on medical gas piping for each specified zone.
- B. At the owner's request, pressure transducers may be installed inside the Zone Alarm Panel. Connect tubing from the zone medical gas piping to the transducers located inside the Zone Alarm Panel. Tubing size varies from 1/4" to 3/8" depending on the manufacturer connection size.
- C. General Requirements for Medical Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
1. Mounting: Recessed installation.
 2. Enclosures: Fabricated from minimum 0.047-inch- thick steel or minimum 0.05-inch- thick aluminum, with knockouts for electrical and piping connections.

2.5 ZONE AND MASTER ALARM PANELS

- A. Provide Zone and Master Alarm Panels and extend signal wiring as scheduled in the contract documents. Separate trouble alarm signals; gauges; and indicators for medical piping systems derived from main equipment or cylinder systems. Include alarm signals when the following conditions exist:
1. Oxygen – O₂: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.

2. Medical Air - MA: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
 3. Medical Vacuum - MV: Vacuum drops below 12-in. Hg (305 mmHg)
- B. Master Alarm Panels shall have the following alarm points:
1. Oxygen - O₂
 - a. Oxygen Main Line Pressure High
 - b. Oxygen Main Line Pressure Low
 - c. Oxygen Main Bulk Tank Liquid Supply Level Low, Less Than 1 Day (Low Contents)
 - d. Oxygen Reserve Tank In Use
 - e. Oxygen Reserve Tank Liquid Supply Level Low, Less Than 1 Day (Low Contents)
 - f. Oxygen Reserve Pressure Low (Not Functional)
 2. Medical Air - MA
 - a. Medical Air Main Line Pressure High
 - b. Medical Air Main Line Pressure Low
 - c. Medical Air Dew Point High
 - d. Medical Air Carbon Monoxide-CO Level High
 - e. Medical Air System Fault
 3. Medical Vacuum – MV
 - a. Medical Vacuum Main Line Pressure Low
 - b. Medical Vacuum Lag Pump In Use
 - c. Medical Vacuum System Fault
- C. All medical gas system low voltage wiring shall be # 18 AWG STP, 24 Volt, twisted & shielded similar to Belden # 1023A or acceptable equal. Wiring shall be normally closed circuit and run in an EMT conduit for above ground inside the building. Run rigid galvanized conduit for exterior use and below grade or slab. Exact routing shall be field verified. Minimum conduit size shall be determined by the total number of wirings as recommended by the manufacturer. Label all junction boxes and label all conduits (every 15' to 20' intervals) with "MEDICAL GAS ALARM SIGNAL WIRING".
- D. For installing connections to existing master alarm panels notify the Owner, the Architect and the Engineer with minimum five (5) business days prior to commencing work. Provide Two New Connections to Master Alarm Panels. The installation of new connections to master alarm panels shall be as follows:
1. Existing wiring shall be replaced with new.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - a. Scrub to ensure complete cleaning.
 - b. Rinse with clean, hot water to remove cleaning solution.

3.2 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

- A. Panels for medical piping systems may be combined in single panels unless otherwise noted.
- B. Install medical gas piping alarm system components; wiring, conduits, etc. in locations required and in accordance with NFPA 99.
- C. Install medical piping system area and master alarm panels where indicated on the drawings.

3.3 POWER REQUIREMENTS

- A. All medical gas system equipment power source shall be from Essential Electrical System Emergency Power - Equipment Branch. Refer to electrical drawings.
 - 1. Equipment such as but not limited to:
 - a. Medical Air Compressor Systems
 - b. Medical Vacuum Pump Systems
 - c. Waste Anesthetic Gas Disposal Systems – WAGD
 - d. Medical Gas Manifold Systems
- B. All medical gas system alarms and control power source shall be from Essential Emergency Power - Life Safety Branch. Refer to electrical drawings.
 - 1. Alarms and controls such as but not limited to:
 - a. Master Alarms
 - b. Zone Alarms
 - c. Alarm Switches
 - d. Alarm Sensors
 - e. Signals from Bulk Liquid Oxygen Systems
- C. All signal wiring shall run in separate rigid conduits. Refer to electrical drawings.

3.4 LABELING AND IDENTIFICATION

- A. Install identifying labels on medical gas outlets, per the requirements of NFPA 99.

END OF SECTION 226139

SECTION 230000

GENERAL HVAC REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.02 COORDINATION

- A. Divisions 20, 21, 22 and 23 are used to communicate the requirements for the total Mechanical scope of work. It is intended for these four Divisions to serve as a single document, communicating the Mechanical scope of work.
- B. Division 20 Specifications serve as common Mechanical requirements that apply to all Division 21, 22, and 23 Specifications and Scope of Work.
- C. All requirements of Division 20 Specifications shall apply to all Division 23 Specifications and Scope of Work, unless noted otherwise.
- D. Coordinate and furnish in writing to the Architect information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.
- E. Coordination drawings shall be prepared as defined in Division 01. No installation of permanent systems shall proceed until the coordination drawings are reviewed by the Architect. No extra charges shall be allowed for changes required to accommodate installation of systems provided under other divisions of this contract.
- F. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
- G. When work is installed without proper coordination, changes to this work deemed necessary by the Architect shall be made to correct the conditions without extra cost to the Owner.
- H. The value of the coordination drawings shall be identified as a line item in the Schedule of Values. If the coordination drawings are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of coordination drawings shall be a minimum of two (2.0) percent of this Contract Amount.

1.03 SCOPE OF WORK

- A. It is intended for the Division 20 Specifications to serve as common requirements that apply to all Division 21, 22, and 23 Specifications and Scope of Work. All requirements of the Division 20 Specifications shall apply to all Division 23 Specifications and Scope of Work, unless noted otherwise.

- B. It is intended for the Division 20, 21, 22, 23 scope of work to include complete and functional Mechanical systems - including all required materials, labor, equipment, and services necessary to achieve the desired final product. It is further intended for the Division 23 scope of work to include coordination with Divisions 21 and 22 for complete Fire Protection, Plumbing, and HVAC systems.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Three phase electric motors.

1.02 RELATED REQUIREMENTS

- A. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. {RSTEMP#79}ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.{CH#126944}.
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
- C. NEMA MG 00001 - Motors and Generators.
- D. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Baldor Electric Company/ABB Group: www.baldor.com/#sle.
- B. Leeson Electric Corporation: www.leeson.com/#sle.

- C. Regal-Beloit Corporation (Century): www.centuryelectricmotor.com/#sle.
- D. Substitutions: See Section 016000 - Product Requirements.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: Refer to Section 260583 for required electrical characteristics.
- B. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.
- B. Single phase motors for fans, blowers, and pumps: Capacitor start, capacitor run type.

2.04 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

- D. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.
- E. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- G. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum {RS#79}, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

SECTION 230517

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe sleeves.
- B. Pipe-sleeve seals.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 230523 - General-Duty Valves for HVAC Piping.
- C. Section 230553 - Identification for HVAC Piping and Equipment: Piping identification.
- D. Section 230719 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- B. {RSTEMP#1152}
- C. FM (AG) - FM Approval Guide.
- D. UL (DIR) - Online Certifications Directory.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A. Manufacturers:
 - 1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- C. Pipe Passing Through Mechanical Room above Basement:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material in compliance with {RS#1152} in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

2.02 PIPE-SLEEVE SEALS

- A. Manufacturers:
 - 1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com/#sle.
 - 2. American Polywater Corporation; PGKD Modular Seals: www.polywater-haufftechnik.com/#sle.
 - 3. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Modular Mechanical Sleeve-Seal:
 - 1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
 - 2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
 - 3. Size and select seal component materials in accordance with service requirements.
 - 4. Service Requirements:
 - a. Fire Resistant: 1 hour, UL (DIR) approved.
 - 5. Glass-reinforced plastic pressure end plates.
- C. Sealing Compounds:
 - 1. Provide packing and sealing compound to fill pipe to sleeve thickness.
 - 2. Combined packing and seal compound is to match partition fire-resistance hourly rating.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Provide sleeves when penetrating floors and walls. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 1. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
- E. Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a water-tight seal.
 - 6. Install in accordance with manufacturer's recommendations.
- F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

SECTION 230519

METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.
- C. Static pressure gauges.
- D. Filter gauges.

1.02 RELATED REQUIREMENTS

- A. Section 230923 - Direct-Digital Control System for HVAC.
- B. Section 230993 - Sequence of Operations for HVAC Controls.
- C. Section 232113 - Hydronic Piping.
- D. Section 232213 - Steam and Condensate Heating Piping.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks.
- B. ASME B40.100 - Pressure Gauges and Gauge Attachments.
- C. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers.
- D. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
- E. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance.
- F. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

1.05 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Trerice
 - 3. Weksler
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.

2.02 PRESSURE GAUGE TAPPINGS

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Omega Engineering, Inc: www.omega.com/#sle.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: 3/4 inch NPT brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F.

2.04 TEST PLUGS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Watts Water Technologies, Inc: www.watts.com/#sle.
 - 3. Weiss Instruments, LLC: www.weissinstruments.com/#sle.
 - 4. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
- C. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Viton core for temperatures up to 400 degrees F.

2.05 STATIC PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Veris Industries: www.veris.com/#sle.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- C. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
- C. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- F. Locate test plugs adjacent thermometers and thermometer sockets.

3.02 SCHEDULE

- A. Pressure Gauges, Location and Scale Range:
 - 1. Pumps, 0 to 100 psi.
- B. Pressure Gauge Tappings, Location:
 - 1. Control valves 3/4 inch & larger - inlets and outlets.
 - 2. Major coils - inlets and outlets.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Headers to central equipment, 0 to 400 degrees F.
- D. Thermometer Sockets, Location:
 - 1. Control valves 1 inch & larger - inlets and outlets.
- E. Static Pressure and Filter Gauges, Location and Scale Range:

1. Unitary filter sections, 0 to 5 inches W.C..

SECTION 230523
GENERAL-DUTY VALVES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Bronze Angle Valves.
 - 1. Class 125 with Bronze Disc.
 - 2. Class 125 with Nonmetallic Disc.
 - 3. Class 150 with Bronze Disc.
 - 4. Class 150 with Nonmetallic Disc.
- B. Brass Ball Valves.
 - 1. One-Piece, Reduced-Port with Brass Trim.
 - 2. Two-Piece, Full-Port with Brass Trim.
 - 3. Two-Piece, Full-Port with Stainless-Steel Trim.
 - 4. Two-Piece, Regular-Port with Brass Trim.
 - 5. Two-Piece, Regular-Port with Stainless-Steel Trim.
 - 6. Three-Piece, Full-Port with Brass Trim.
 - 7. Three-Piece, Full-Port with Stainless-Steel Trim.
- C. Bronze Ball Valves
 - 1. One-Piece, Reduced-Port with Bronze Trim.
 - 2. One-Piece, Reduced-Port with Stainless-Steel Trim.
 - 3. Two-Piece, Full-Port with Bronze Trim.
 - 4. Two-Piece, Full-Port with Stainless-Steel Trim.
 - 5. Two-Piece, Regular-Port with Bronze Trim.
 - 6. Two-Piece, Regular-Port with Stainless-Steel Trim.
 - 7. Three-Piece, Full-Port with Bronze Trim.
 - 8. Three-Piece, Full-Port with Stainless-Steel Trim.
- D. Iron Ball Valves.
 - 1. Class 125.
- E. Iron, Single-Flange Butterfly Valves.
 - 1. 150 CWP with EPDM Seat and Aluminum-Bronze Disc.
 - 2. 150 CWP with NBR Seat and Aluminum-Bronze Disc.
 - 3. 150 CWP with EPDM Seat and Ductile-Iron Disc.
 - 4. 150 CWP with NBR Seat and Ductile-Iron Disc.
 - 5. 150 CWP with EPDM Seat and Stainless-Steel Disc.
 - 6. 150 CWP with NBR Seat and Stainless-Steel Disc.
 - 7. 200 CWP with EPDM Seat and Aluminum-Bronze Disc.
 - 8. 200 CWP with EPDM Seat and Aluminum-Bronze Disc.
 - 9. 200 CWP with EPDM Seat and Ductile-Iron Disc.
 - 10. 200 CWP with NBR Seat and Ductile-Iron Disc.
 - 11. 200 CWP with EPDM Seat and Stainless-Steel Disc.

- 12. 200 CWP with NBR Seat and Stainless-Steel Disc.
- F. Iron, Grooved-End Butterfly Valves.
 - 1. 175 CWP.
 - 2. 300 CWP.
- G. High-Performance Butterfly Valves.
 - 1. Class 150, Single-Flange.
 - 2. Class 300, Single-Flange.
- H. Bronze Lift Check Valves.
 - 1. Class 125 with Bronze Disc.
 - 2. Class 125 with Nonmetallic Disc.
- I. Bronze Swing Check Valves.
 - 1. Class 125 with Bronze Disc.
 - 2. Class 125 with Nonmetallic Disc.
 - 3. Class 150 with Bronze Disc.
 - 4. Class 150 with Nonmetallic Disc.
- J. Iron Swing Check Valves.
 - 1. Class 125 with Metal Seats.
 - 2. Class 125 with Nonmetallic-to-Metal Seats.
 - 3. Class 250 with Metal Seats.
- K. Iron Swing Check Valves with Closure Control.
 - 1. Class 125 with Lever- and Spring-Closure Control.
 - 2. Class 125 with Lever- and Weight-Closure Control.
- L. Iron, Grooved-End Swing Check Valves.
 - 1. 300 CWP.
- M. Iron, Center-Guided Check Valves.
 - 1. Class 125, Compact-Wafer, with Metal Seat.
 - 2. Class 125, Globe, with Metal Seat.
 - 3. Class 150, Compact-Wafer, with Metal Seat.
 - 4. Class 150, Globe, with Metal Seat.
 - 5. Class 250, Compact-Wafer, with Metal Seat.
 - 6. Class 250, Globe, with Metal Seat.
 - 7. Class 300, Compact-Wafer, with Metal Seat.
 - 8. Class 300, Globe, with Metal Seat.
 - 9. Class 125, Compact-Wafer, with Resilient Seat.
 - 10. Class 125, Globe, with Resilient Seat.
 - 11. Class 150, Compact-Wafer, with Resilient Seat.
 - 12. Class 150, Globe, with Resilient Seat.
 - 13. Class 250, Compact-Wafer, with Resilient Seat.
 - 14. Class 250, Globe, with Resilient Seat.
 - 15. Class 300, Compact-Wafer, with Resilient Seat.
 - 16. Class 300, Globe, with Resilient Seat.
- N. Iron, Plate-Type Check Valves.

1. Class 125, Dual-Plate with Metal Seat.
 2. Class 150, Dual-Plate with Metal Seat.
 3. Class 250, Dual-Plate with Metal Seat.
 4. Class 300, Dual-Plate with Metal Seat.
 5. Class 125, Single-Plate with Resilient Seat.
 6. Class 125, Dual-Plate with Resilient Seat.
 7. Class 150, Dual-Plate with Resilient Seat.
 8. Class 250, Wafer, Single-Plate with Resilient Seat.
 9. Class 250, Dual-Plate with Resilient Seat.
 10. Class 300, Dual-Plate with Resilient Seat.
- O. Bronze Gate Valves.
1. Class 125, NRS.
 2. Class 125, RS.
 3. Class 150, NRS.
 4. Class 150, RS.
- P. Iron Gate Valves.
1. Class 125, NRS.
 2. Class 125, OS&Y.
 3. Class 250, NRS.
 4. Class 250, OS&Y.
- Q. Bronze Globe Valves.
1. Class 125 with Bronze Disc.
 2. Class 125 with Nonmetallic Disc.
 3. Class 150 with Nonmetallic Disc.
- R. Iron Globe Valves.
1. Class 125.
 2. Class 250.
- S. Lubricated Plug Valves.
1. Class 125, Regular-Gland with Threaded Ends.
 2. Class 125, Regular-Gland with Flanged Ends.
 3. Class 125, Cylindrical with Threaded Ends.
 4. Class 125, Cylindrical with Flanged Ends.
 5. Class 250, Regular-Gland with Threaded Ends.
 6. Class 250, Regular-Gland with Flanged Ends.
 7. Class 250, Cylindrical with Threaded Ends.
 8. Class 250, Cylindrical with Flanged Ends.
- T. Eccentric Plug Valves.
1. 175 CWP with Resilient Seating.
- U. Drain Valves.
- V. Chainwheels.
- W. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

- X. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 083100 - Access Doors and Panels.
- C. Section 230548 - Vibration and Seismic Controls for HVAC.
- D. Section 230553 - Identification for HVAC Piping and Equipment.
- E. Section 230716 - HVAC Equipment Insulation.
- F. Section 230719 - HVAC Piping Insulation.
- G. Section 232113 - Hydronic Piping.
- H. Section 232213 - Steam and Condensate Heating Piping.
- I. CWP: Cold working pressure.
- J. EPDM: Ethylene propylene copolymer rubber.
- K. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- L. NRS: Nonrising stem.
- M. OS&Y: Outside screw and yoke.
- N. PTFE: Polytetrafluoroethylene.
- O. RS: Rising stem.
- P. TFE: Tetrafluoroethylene.
- Q. WOG: Water, oil, and gas.
- R. WSP: Working steam pressure.

1.03 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B. Operation and Maintenance Materials
 - 1. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- C. Welding Materials and Procedures: Comply with ASME BPVC-IX.
- D. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Valve Actuator Types:

4. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 5. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 6. Secure check valves in either the closed position or open position.
 7. Adjust butterfly valves to closed or partially closed position.
- E. Use the following precautions during storage:
1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
- F. Exercise the following precautions for handling:
1. Handle large valves with sling, modified to avoid damage to exposed parts.
 2. Avoid the use of operating handles or stems as rigging or lifting points.
- G. Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 2. Handwheel: For valves other than quarter-turn types.
 3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- G. Valves in Insulated Piping: With 2 inch stem extensions and the following features:
1. Gate Valves: With rising stem.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 3. Butterfly Valves: With extended neck.

H. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606 .
3. Solder Joint: With sockets according to ASME B16.18.
 - a. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.
4. Threaded: With threads according to ASME B1.20.1.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:

- a. Hammond Valve.
- b. Milwaukee Valve Company.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze or aluminum.

B. Class 125, Bronze Angle Valves with Nonmetallic Disc:

- a. American Valve, Inc.
- b. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.

C. Class 150, Bronze Angle Valves with Bronze Disc:

- a. Crane Co.
- b. Kitz Corporation.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze or aluminum.

D. Class 150, Bronze Angle Valves with Nonmetallic Disc:

- a. Crane Valve Group; Crane Valves.
- b. Crane Valve Group; Jenkins Valves.
- c. Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Milwaukee Valve Company.
- f. Nibco.
- g. Powell Valves.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.

2.03 BRASS BALL VALVES

A. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:

- a. Kitz Corporation.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Reduced.

B. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. DynaQuip Controls.
- d. Flow-Tek, Inc.
- e. Hammond Valve.
- f. Jamesbury; a subsidiary of Metso Automation.
- g. Jomar Valve.
- h. Kitz Corporation.
- i. Legend Valve.
- j. Marwin Valve.
- k. Milwaukee Valve Company.
- l. NIBCO.
- m. Red-White Valve Corporation.
- n. RuB.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.

- c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- C. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
- a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Flow-Tek, Inc.
 - d. Hammond Valve.
 - e. Jamesbury.
 - f. Kitz Corporation.
 - g. Marwin Valve.
 - h. Milwaukee Valve Company.
 - i. RuB.
2. Description:
- a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig .
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.
- D. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
- a. Hammond Valve.
 - b. Jamesbury.
 - c. Legend Valve.
 - d. Marwin Valve.
 - e. Milwaukee Valve Company.
2. Description:
- a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Regular.
- E. Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:

- a. Jamesbury.
 - b. Marwin Valve.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Brass or bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Regular.
- F. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
- a. Jomar Valve.
 - b. Kitz Corporation.
 - c. Red-White Valve Corporation.
 - d. Watts.
2. Description:
- a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Brass.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- G. Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
- a. Jomar Valve.
 - b. Kitz Corporation.
 - c. Marwin Valve.
 - d. Watts.
2. Description:
- a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three piece.
 - e. Body Material: Forged brass.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.04 BRONZE BALL VALVES

- A. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:
 - a. American Valve.
 - b. Conbraco Industries; Apollo Valves.
 - c. Nibco.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Reduced.
- B. One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - a. Conbraco Industries; Apollo Valves.
 - b. Nibco.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Reduced.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - a. American Valve.
 - b. Conbraco Industries; Apollo Valves.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Hammond Valve.
 - e. Lance Valves.
 - f. Legend Valve.
 - g. Milwaukee Valve Company.
 - h. Nibco.
 - i. Red-White Valve Corporation.
 - j. Watts.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.

- h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - a. Conbraco Industries.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Lance Valves.
 - e. Milwaukee Valve Company.
 - f. Nibco.
 - g. Watts.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.
- E. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
 - a. American Valve.
 - b. Conbraco Industries.; Apollo Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. DynaQuip Controls.
 - f. Hammond Valve.
 - g. Lance Valves.
 - h. Milwaukee Valve Company.
 - i. Nibco.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Regular.
- F. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - a. Conbraco Industries.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Hammond Valve.

- d. Milwaukee Valve Company.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Regular.
- G. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - a. Conbraco Industries; Apollo Valves.
 - b. DynaQuip Controls.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. Nibco.
 - f. Red-White Valve Corporation.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.
- H. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - a. Conbraco Industries; Apollo Valves.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. Nibco.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.05 IRON BALL VALVES

- A. Class 125, Iron Ball Valves:
 - a. American Valve.
 - b. Conbraco Industries; Apollo Valves.
 - c. Kitz Corporation.
 - d. Sure Flow Equipment.
 - e. Watts.
- 2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Split body.
 - d. Body Material: ASTM A126, gray iron.
 - e. Ends: Flanged.
 - f. Seats: PTFE or TFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel.
 - i. Port: Full.

2.06 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - a. ABZ Valve and Controls.
 - b. Bray Controls.
 - c. Conbraco Industries; Apollo Valves.
 - d. Cooper Cameron Valves.
 - e. Crane Co.; Crane Valve Group; Jenkins Valves.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Milwaukee Valve Company.
 - k. Nibco.
 - l. Norriseal.
 - m. Red-White Valve Corporation.
 - n. Spence Strainers International.
 - o. Tyco Valves & Controls.
 - p. Watts.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- B. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
 - a. ABZ Valve and Controls.

- b. Bray Controls.
 - c. Conbraco Industries.; Apollo Valves.
 - d. Cooper Cameron Valves.
 - e. Crane Co.; Crane Valve Group; Jenkins Valves.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Milwaukee Valve Company.
 - k. Nibco.
 - l. Norriseal.
 - m. Red-White Valve Corporation.
 - n. Spence Strainers International.
 - o. Tyco Valves & Controls.
 - p. Watts.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
- C. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Bray Controls; a division of Bray International.
 - c. Conbraco Industries, Inc.; Apollo Valves.
 - d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - e. Crane Co.; Crane Valve Group; Center Line.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Milwaukee Valve Company.
 - k. Mueller Steam Specialty; a division of SPX Corporation.
 - l. NIBCO INC.
 - m. Norriseal; a Dover Corporation company.
 - n. Spence Strainers International; a division of CIRCOR International.
 - o. Sure Flow Equipment Inc.
 - p. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: EPDM.

- f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- D. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Bray Controls; a division of Bray International.
 - c. Conbraco Industries, Inc.; Apollo Valves.
 - d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - e. Crane Co.; Crane Valve Group; Center Line.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Milwaukee Valve Company.
 - k. Mueller Steam Specialty; a division of SPX Corporation.
 - l. NIBCO INC.
 - m. Norriseal; a Dover Corporation company.
 - n. Spence Strainers International; a division of CIRCOR International.
 - o. Sure Flow Equipment Inc.
 - p. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- E. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Bray Controls; a division of Bray International.
 - c. Conbraco Industries, Inc.; Apollo Valves.
 - d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - e. Crane Co.; Crane Valve Group; Jenkins Valves.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Milwaukee Valve Company.
 - k. Mueller Steam Specialty; a division of SPX Corporation.
 - l. NIBCO INC.
 - m. Norriseal; a Dover Corporation company.
 - n. Red-White Valve Corporation.
 - o. Spence Strainers International; a division of CIRCOR International.
 - p. Sure Flow Equipment Inc.
 - q. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.
- F. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
 - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Bray Controls; a division of Bray International.
 - c. Conbraco Industries, Inc.; Apollo Valves.
 - d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - e. Crane Co.; Crane Valve Group; Jenkins Valves.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Milwaukee Valve Company.
 - k. Mueller Steam Specialty; a division of SPX Corporation.
 - l. NIBCO INC.
 - m. Norriseal; a Dover Corporation company.
 - n. Red-White Valve Corporation.
 - o. Spence Strainers International; a division of CIRCOR International.
 - p. Sure Flow Equipment Inc.
 - q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.
- G. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - a. ABZ Valve and Controls; a division of ABZ Manufacturing.
 - b. Conbraco Industries; Apollo Valves.
 - c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - d. Crane Valve Group; Jenkins Valves.
 - e. Crane Valve Group; Stockham Division.
 - f. DeZurik Water Controls.
 - g. Flo Fab.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Legend Valve.
 - k. Milwaukee Valve Company.

- I. Nibco.
 - m. Norriseal; a Dover Corporation company.
 - n. Red-White Valve Corporation.
 - o. Spence Strainers International; a division of CIRCOR International.
 - p. Watts Regulator Co.; a division of Watts Water Technologies.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
 - H. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
 - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Division.
 - f. DeZurik Water Controls.
 - g. Flo Fab Inc.
 - h. Hammond Valve.
 - i. Kitz Corporation.
 - j. Legend Valve.
 - k. Milwaukee Valve Company.
 - l. NIBCO INC.
 - m. Norriseal; a Dover Corporation company.
 - n. Red-White Valve Corporation.
 - o. Spence Strainers International; a division of CIRCOR International.
 - p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.
 - I. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
 - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. American Valve, Inc.
 - c. Conbraco Industries, Inc.; Apollo Valves.
 - d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - e. Crane Co.; Crane Valve Group; Center Line.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.

- h. Flo Fab Inc.
 - i. Hammond Valve.
 - j. Kitz Corporation.
 - k. Legend Valve.
 - l. Milwaukee Valve Company.
 - m. Mueller Steam Specialty; a division of SPX Corporation.
 - n. NIBCO INC.
 - o. Norriseal; a Dover Corporation company.
 - p. Spence Strainers International; a division of CIRCOR International.
 - q. Sure Flow Equipment Inc.
 - r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.
- J. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. American Valve, Inc.
 - c. Conbraco Industries, Inc.; Apollo Valves.
 - d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - e. Crane Co.; Crane Valve Group; Center Line.
 - f. Crane Co.; Crane Valve Group; Stockham Division.
 - g. DeZurik Water Controls.
 - h. Flo Fab Inc.
 - i. Hammond Valve.
 - j. Kitz Corporation.
 - k. Legend Valve.
 - l. Milwaukee Valve Company.
 - m. Mueller Steam Specialty; a division of SPX Corporation.
 - n. NIBCO INC.
 - o. Norriseal; a Dover Corporation company.
 - p. Spence Strainers International; a division of CIRCOR International.
 - q. Sure Flow Equipment Inc.
 - r. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Nickel-plated or -coated ductile iron.

K. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. American Valve, Inc.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- e. Crane Co.; Crane Valve Group; Jenkins Valves.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Flo Fab Inc.
- i. Hammond Valve.
- j. Kitz Corporation.
- k. Legend Valve.
- l. Milwaukee Valve Company.
- m. Mueller Steam Specialty; a division of SPX Corporation.
- n. NIBCO INC.
- o. Norriseal; a Dover Corporation company.
- p. Red-White Valve Corporation.
- q. Spence Strainers International; a division of CIRCOR International.
- r. Sure Flow Equipment Inc.
- s. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- e. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
- f. Seat: EPDM.
- g. Stem: One- or two-piece stainless steel.
- h. Disc: Stainless steel.

L. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. American Valve, Inc.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- e. Crane Co.; Crane Valve Group; Jenkins Valves.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Flo Fab Inc.
- i. Hammond Valve.
- j. Kitz Corporation.
- k. Legend Valve.
- l. Milwaukee Valve Company.
- m. Mueller Steam Specialty; a division of SPX Corporation.
- n. NIBCO INC.
- o. Norriseal; a Dover Corporation company.
- p. Red-White Valve Corporation.
- q. Spence Strainers International; a division of CIRCOR International.

- r. Sure Flow Equipment Inc.
- s. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Stainless steel.

2.07 IRON, GROOVED-END BUTTERFLY VALVES

- A. 175 CWP, Iron, Grooved-End Butterfly Valves:
 - a. Kennedy Valve; a division of McWane, Inc.
 - b. Shurjoint Piping Products.
 - c. Tyco Fire Products LP; Grinnell Mechanical Products.
 - d. Victaulic Company.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 175 psig.
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: Coated, ductile iron.
 - f. Seal: EPDM.
- B. 300 CWP, Iron, Grooved-End Butterfly Valves:
 - a. Anvil International, Inc.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Mueller Steam Specialty; a division of SPX Corporation.
 - d. NIBCO INC.
 - e. Shurjoint Piping Products.
 - f. Tyco Fire Products LP; Grinnell Mechanical Products.
 - g. Victaulic Company.
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 8 and Smaller CWP Rating: 300 psig.
 - c. NPS 10 and Larger CWP Rating: 200 psig.
 - d. Body Material: Coated, ductile iron.
 - e. Stem: Two-piece stainless steel.
 - f. Disc: Coated, ductile iron.
 - g. Seal: EPDM.

2.08 HIGH-PERFORMANCE BUTTERFLY VALVES

- A. Class 150, Single-Flange, High-Performance Butterfly Valves:
 - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Bray Controls; a division of Bray International.
 - c. Cooper Cameron Valves; a division of Cooper Cameron Corp.

- d. Crane Valve Group; Flowseal.
- e. Crane Valve Group; Stockham Division.
- f. DeZurik Water Controls.
- g. Hammond Valve.
- h. Jamesbury; a subsidiary of Metso Automation.
- i. Milwaukee Valve Company.
- j. NIBCO INC.
- k. Process Development & Control, Inc.
- l. Tyco Valves & Controls; a unit of Tyco Flow Control.
- m. Xomox Corporation.
- 2. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 285 psig at 100 deg F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
 - e. Seat: Reinforced PTFE or metal.
 - f. Stem: Stainless steel; offset from seat plane.
 - g. Disc: Carbon steel.
 - h. Service: Bidirectional.
- B. Class 300, Single-Flange, High-Performance Butterfly Valves:
 - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Bray Controls; a division of Bray International.
 - c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - d. Crane Valve Group; Flowseal.
 - e. Crane Valve Group; Stockham Division.
 - f. DeZurik Water Controls.
 - g. Hammond Valve.
 - h. Jamesbury; a subsidiary of Metso Automation.
 - i. Milwaukee Valve Company.
 - j. NIBCO INC.
 - k. Process Development & Control, Inc.
 - l. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - m. Xomox Corporation.
- 2. Description:
 - a. Standard: MSS SP-68.
 - b. CWP Rating: 720 psig at 100 deg F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: Carbon steel, cast iron, or ductile iron.
 - e. Seat: Reinforced PTFE or metal.
 - f. Stem: Stainless steel; offset from seat plane.
 - g. Disc: Carbon steel.
 - h. Service: Bidirectional.

2.09 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Bronze Disc:
 - a. Crane Co.; Crane Valve Group; Crane Valves.

- b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B61 or ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- B. Class 125, Lift Check Valves with Nonmetallic Disc:
 - a. Flo Fab Inc.
 - b. Hammond Valve.
 - c. Kitz Corporation.
 - d. Milwaukee Valve Company.
 - e. Mueller Steam Specialty; a division of SPX Corporation.
 - f. NIBCO INC.
 - g. Red-White Valve Corporation.
 - h. CWP Rating: 200 psig.
 - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B61 or ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: NBR, PTFE, or TFE.

2.10 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - l. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

- B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Hammond Valve.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corporation.
 - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.
- C. Class 150, Bronze Swing Check Valves with Bronze Disc:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corporation.
 - i. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- D. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE or TFE.

2.11 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

- a. Crane Valve Group; Crane Valves.
- b. Crane Valve Group; Jenkins Valves.
- c. Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Kitz Corporation.
- f. Legend Valve.
- g. Milwaukee Valve Company.
- h. Nibco.
- i. Powell Valves.
- j. Red-White Valve Corporation.
- k. Sure Flow Equipment.
- l. Watts Regulator Co.; a division of Watts Water Technologies.
- m. Zy-Tech Global Industries.

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Ends: Flanged.
- h. Trim: Composition.
- i. Seat Ring: Bronze.
- j. Disc Holder: Bronze.
- k. Disc: PTFE or TFE.
- l. Gasket: Asbestos free.

C. Class 250, Iron Swing Check Valves with Metal Seats:

- a. Crane Valve Group; Crane Valves.
- b. Crane Valve Group; Jenkins Valves.
- c. Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Milwaukee Valve Company.
- f. NIBCO INC.

- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.

2.12 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
 - a. NIBCO INC.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.
 - i. Closure Control: Factory-installed, exterior lever and spring.
- B. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
 - a. Crane Co.; Crane Valve Group; Crane Valves.Crane Co.; Crane Valve Group; Jenkins Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.
 - i. Closure Control: Factory-installed, exterior lever and weight.

2.13 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP, Iron, Grooved-End Swing Check Valves:
 - a. Anvil International, Inc.
 - b. Val-Matic Valve & Manufacturing Corp.

- c. Shurjoint Piping Products.
- d. Tyco Fire Products LP; Grinnell Mechanical Products.
- e. Victaulic Company.
- 2. Description:
 - a. CWP Rating: 300 psig.
 - b. Body Material: ASTM A536, ductile iron.
 - c. Seal: EPDM.
 - d. Disc: Spring operated ductile iron or stainless steel.

2.14 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:

- a. Anvil International, Inc.
- b. APCO Willamette Valve and Primer Corporation.
- c. Crispin Valve.
- d. DFT Inc.
- e. Flo Fab Inc.
- f. GA Industries, Inc.
- g. Hammond Valve.
- h. Metraflex, Inc.
- i. Milwaukee Valve Company.
- j. Mueller Steam Specialty; a division of SPX Corporation.
- k. NIBCO INC.
- l. Spence Strainers International; a division of CIRCOR International.
- m. Sure Flow Equipment Inc.
- n. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Compact wafer.
 - f. Seat: Bronze.

B. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:

- a. APCO Willamette Valve and Primer Corporation.
- b. Crispin Valve.
- c. DFT Inc.
- d. Flomatic Corporation.
- e. Hammond Valve.
- f. Metraflex, Inc.
- g. Milwaukee Valve Company.
- h. Mueller Steam Specialty; a division of SPX Corporation.
- i. NIBCO INC.
- j. Spence Strainers International; a division of CIRCOR International.
- k. Sure Flow Equipment Inc.
- l. Val-Matic Valve & Manufacturing Corp.
- m. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-125.

- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- C. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Compact wafer.
- D. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- E. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. DFT Inc.
 - d. Flo Fab Inc.
 - e. Hammond Valve.
 - f. Metraflex, Inc.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Sure Flow Equipment Inc.
 - j. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Compact wafer, spring loaded.
 - f. Seat: Bronze.

- F. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. DFT Inc.
 - d. Flomatic Corporation.
 - e. Hammond Valve.
 - f. Metraflex, Inc.
 - g. Milwaukee Valve Company.
 - h. Mueller Steam Specialty; a division of SPX Corporation.
 - i. NIBCO INC.
 - j. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- G. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Compact wafer, spring loaded.
 - f. Seat: Bronze.
- H. Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- I. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. DFT Inc.
 - d. Flo Fab Inc.
 - e. Hammond Valve.

- f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Spence Strainers International; a division of CIRCOR International.
 - i. Sure Flow Equipment Inc.
 - j. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Compact wafer.
 - f. Seat: EPDM or NBR.
- J. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
- a. Anvil International, Inc.
 - b. APCO Willamette Valve and Primer Corporation.
 - c. Crispin Valve.
 - d. DFT Inc.
 - e. GA Industries, Inc.
 - f. Hammond Valve.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Sure Flow Equipment Inc.
 - j. Val-Matic Valve & Manufacturing Corp.
2. Description:
- a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: EPDM or NBR.
- K. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
- a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
2. Description:
- a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Compact wafer.
 - f. Seat: EPDM or NBR.
- L. Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
- a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. DFT Inc.
 - d. Val-Matic Valve & Manufacturing Corp.

2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: EPDM or NBR.
- M. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. DFT Inc.
 - d. Flo Fab Inc.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Sure Flow Equipment Inc.
 - i. Val-Matic Valve & Manufacturing Corp.
2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Compact wafer, spring loaded.
 - f. Seat: EPDM or NBR.
- N. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. DFT Inc.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Val-Matic Valve & Manufacturing Corp.
2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: EPDM or NBR.
- O. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
2. Description:
 - a. Standard: MSS SP-125.

- b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Compact wafer, spring loaded.
 - f. Seat: EPDM or NBR.
- P. Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: EPDM or NBR.

2.15 IRON, PLATE-TYPE CHECK VALVES

- A. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Flomatic Corporation.
 - d. Mueller Steam Specialty; a division of SPX Corporation.
- 2. Description:
 - a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A126, gray iron.
 - f. Seat: Bronze.
- B. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Mueller Steam Specialty; a division of SPX Corporation.
 - d. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - f. Seat: Bronze.
- C. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.

- 2. Description:
 - a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A126, gray iron.
 - f. Seat: Bronze.
- D. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Mueller Steam Specialty; a division of SPX Corporation.
 - d. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A395/A395M or ASTM A536 , ductile iron.
 - f. Seat: Bronze.
- E. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
 - a. Flo Fab Inc.
 - b. Sure Flow Equipment Inc.
- 2. Description:
 - a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Wafer, spring-loaded plate.
 - e. Body Material: ASTM A126, gray iron.
 - f. Seat: EPDM or NBR.
- F. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Cooper Cameron Valves TVB Techno.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. NIBCO INC.
 - f. Spence Strainers International; a division of CIRCOR International.
 - g. Sure Flow Equipment Inc.
 - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A126, gray iron.
 - f. Seat: EPDM or NBR.
- G. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:

- a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 250 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - f. Seat: EPDM or NBR.
- H. Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
- a. Sure Flow Equipment Inc.
2. Description:
- a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Wafer, spring-loaded plate.
 - e. Body Material: ASTM A126, gray iron.
 - f. Seat: EPDM or NBR.
- I. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
- a. APCO Willamette Valve and Primer Corporation.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Sure Flow Equipment Inc.
2. Description:
- a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A126, gray iron.
 - f. Seat: EPDM or NBR.
- J. Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
- a. APCO Willamette Valve and Primer Corporation.
 - b. Val-Matic Valve & Manufacturing Corp.
2. Description:
- a. Standard: API STD 594.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 400 psig.
 - d. Body Design: Wafer, spring-loaded plates.
 - e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - f. Seat: EPDM or NBR.

2.16 BRONZE GATE VALVES

- A. Class 125, NRS Bronze Gate Valves:
- a. American Valve.
 - b. Crane Valve Group; Crane Valves.

- c. Crane Valve Group; Jenkins Valves.
 - d. Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. Nibco.
 - i. Powell Valves.
 - j. Red-White Valve Corporation.
 - k. Watts Regulator Co.; a division of Watts Water Technologies.
 - l. Zy-Tech Global Industries.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.
- B. Class 125, RS Bronze Gate Valves:
- a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Milwaukee Valve Company.
 - h. NIBCO INC.
 - i. Powell Valves.
 - j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - k. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig
 - c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.
- C. Class 150, NRS Bronze Gate Valves:
- a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Powell Valves.
 - f. Red-White Valve Corporation.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.
- D. Class 150, RS Bronze Gate Valves:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Kitz Corporation.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Powell Valves.
 - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - i. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.

2.17 IRON GATE VALVES

- A. Class 125, NRS, Iron Gate Valves:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Flo Fab Inc.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Legend Valve.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Red-White Valve Corporation.
 - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - m. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.

- d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- B. Class 125, OS&Y, Iron Gate Valves:
- a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Flo Fab Inc.
 - e. Hammond Valve.
 - f. Kitz Corporation.
 - g. Legend Valve.
 - h. Milwaukee Valve Company.
 - i. NIBCO INC.
 - j. Powell Valves.
 - k. Red-White Valve Corporation.
 - l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - m. Zy-Tech Global Industries, Inc.
2. Description:
- a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- C. Class 250, NRS, Iron Gate Valves:
- a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
2. Description:
- a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.
- D. Class 250, OS&Y, Iron Gate Valves:
- a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.

- f. Powell Valves.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

2.18 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Kitz Corporation.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Powell Valves.
 - h. Red-White Valve Corporation.
 - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - j. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze or aluminum.
- B. Class 125, Bronze Globe Valves with Nonmetallic Disc:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
 - d. Red-White Valve Corporation.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.
- C. Class 150, Bronze Globe Valves with Nonmetallic Disc:

- a. Crane Valve Group; Crane Valves.
- b. Hammond Valve.
- c. Kitz Corporation.
- d. Milwaukee Valve Company.
- e. Nibco.
- f. Powell Valves.
- g. Red-White Valve Corporation.
- h. Watts Regulator Co.; a division of Watts Water Technologies.
- i. Zy-Tech Global Industries.
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: PTFE or TFE.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze or aluminum.

2.19 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Kitz Corporation.
- f. Milwaukee Valve Company.
- g. NIBCO INC.
- h. Powell Valves.
- i. Red-White Valve Corporation.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- k. Zy-Tech Global Industries, Inc.
- 2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A126 , gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.

B. Class 250, Iron Globe Valves:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Hammond Valve.
- e. Milwaukee Valve Company.
- f. NIBCO INC.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2. Description:

- a. Standard: MSS SP-85, Type I.
- b. CWP Rating: 500 psig.
- c. Body Material: ASTM A126, gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Packing and Gasket: Asbestos free.

2.20 LUBRICATED PLUG VALVES

- A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - a. Nordstrom Valves, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 - 1. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- D. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- E. Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - a. Nordstrom Valves, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- F. Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 - a. Nordstrom Valves, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type II.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- G. Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - e. Pattern: Regular or short.
 - f. Plug: Cast iron or bronze with sealant groove.
- H. Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 - a. Homestead Valve; a division of Olson Technologies, Inc.
 - b. Milliken Valve Company.
 - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
- 2. Description:
 - a. Standard: MSS SP-78, Type IV.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A48/A48M or ASTM A126, Grade 40 cast iron with lubrication-sealing system.

- e. Pattern: Regular or short.
- f. Plug: Cast iron or bronze with sealant groove.

2.21 ECCENTRIC PLUG VALVES

- A. 175 CWP, Eccentric Plug Valves with Resilient Seating:
 - a. Clow Valve Co.; a division of McWane, Inc.
 - b. DeZurik Water Controls.
 - c. Homestead Valve; a division of Olson Technologies, Inc.
 - d. M&H Valve Company; a division of McWane, Inc.
 - e. Milliken Valve Company.
 - f. Henry Pratt Company.
 - g. Val-Matic Valve & Manufacturing Corp.
- 2. Description:
 - a. Standard: MSS SP-108.
 - b. CWP Rating: 175 psig minimum.
 - c. Body and Plug: ASTM A48/A48M, gray iron; ASTM A126, gray iron; or ASTM A536, ductile iron.
 - d. Bearings: Oil-impregnated bronze or stainless steel.
 - e. Ends: Flanged.
 - f. Stem-Seal Packing: Asbestos free.
 - g. Plug, Resilient-Seating Material: Suitable for potable-water service unless otherwise indicated.

2.22 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
 - 1. Bronze ball valve as specified in this Section.
 - 2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.23 CHAINWHEELS

- 1. Babbitt Steam Specialty Co.
- 2. Roto Hammer Industries.
- 3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to ball butterfly, gate, globe and plug valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron Ductile or cast iron, of type and size required for valve. Include zinc coating.
 - 4. Chain: Hot-dip, galvanized steel Brass, of size required to fit sprocket rim.

PART 3 EXECUTION

3.01 APPLICATION

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, gate, or plug valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 3. Throttling Service, Steam: Globe or angle valves.
 4. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Hydronic: Iron swing check valves with lever and weight or with spring or iron, center-guided, bronze or resilient-seat check valves.
- B. Select valves, except wafer types, with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 4. For Steel Piping, NPS 5 and Larger: Flanged ends.
 5. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.02 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.03 INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for ball butterfly, gate, globe and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
 1. Swing Check Valves: In horizontal position with hinge pin level.
 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 3. Lift Check Valves: With stem upright and plumb.
- G. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

SECTION 230548

VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Vibration-isolated equipment support bases.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.

1.03 DEFINITIONS

- A. HVAC Component: Where referenced in this section in regards to seismic controls, applies to any portion of the HVAC system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., ductwork, piping).

1.04 REFERENCE STANDARDS

- A. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications.
- B. FEMA 412 - Installing Seismic Restraints for Mechanical Equipment.
- C. FEMA 413 - Installing Seismic Restraints for Electrical Equipment.
- D. FEMA 414 - Installing Seismic Restraints for Duct and Pipe.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.

- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
- D. Shop Drawings - Vibration Isolation Systems:
 - 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
 - 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.

1.07 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
 - 3. Select vibration isolators for outdoor equipment to comply with wind design requirements.
- D. Equipment Isolation: As indicated on drawings.

2.02 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.

1.02 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.

- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Ductwork: Nameplates.
- G. Heat Transfer Equipment: Nameplates.
- H. Instrumentation: Tags.
- I. Major Control Components: Nameplates.
- J. Piping: Tags.
- K. Pumps: Nameplates.
- L. Small-sized Equipment: Tags.
- M. Thermostats: Nameplates.
- N. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 5. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
- B. Letter Color: White.
- C. Letter Height: 1/4 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 - 2. Brady Corporation: www.bradycorp.com/#sle.
 - 3. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 4. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 5. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 6. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

- A. Manufacturers:
 - 1. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
- B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- C. Style: Individual Label.
- D. Color: Yellow/Black.

2.05 STENCILS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 3. Insite Solutions, LLC: www.stop-painting.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 5. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. Ductwork and Equipment: 2-1/2 inch high letters.
- C. Stencil Paint: As specified in Section 099123, semi-gloss enamel, colors complying with ASME A13.1.

2.06 PIPE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Brimar Industries, Inc: www.pipemarker.com/#sle.
 - 3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
 - 4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 5. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- E. Color code as follows:
 - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2.07 CEILING TACKS

- A. Manufacturers:
 - 1. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. HVAC Equipment: Yellow.
 - 2. Fire Dampers and Smoke Dampers: Red.
 - 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Use tags on piping 3/4 inch diameter and smaller.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- F. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.03 SCHEDULE

- A. Equipment Type:
 - 1. Identification:
 - 2. Background:
 - a. Size:
 - b. Color:
 - 3. Lettering:
 - a. Size:

b. Color:

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.02 SUBMITTALS

A. Action Submittals

- 1. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- 2. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - a. Submit to Architect.
 - b. Submit to the Commissioning Authority.
 - c. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - d. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - e. Include at least the following in the plan:
 - 1) Preface: An explanation of the intended use of the control system.
 - 2) List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - 3) Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - 4) Identification and types of measurement instruments to be used and their most recent calibration date.
 - 5) Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - 6) Final test report forms to be used.
 - 7) Detailed step-by-step procedures for TAB work for each system and issue, including:
 - (a) Terminal flow calibration (for each terminal type).
 - (b) Diffuser proportioning.
 - (c) Branch/submain proportioning.
 - (d) Total flow calculations.
 - (e) Rechecking.
 - (f) Diversity issues.

- 8) Expected problems and solutions, etc.
 - 9) Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
 - 10) Details of how TOTAL flow will be determined; for example:
 - (a) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - (b) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - 11) Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - 12) Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - 13) Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - 14) Method of checking building static and exhaust fan and/or relief damper capacity.
 - 15) Proposed selection points for sound measurements and sound measurement methods.
 - 16) Methods for making coil or other system plant capacity measurements, if specified.
 - 17) Time schedule for TAB work to be done in phases (by floor, etc.).
 - 18) Description of TAB work for areas to be built out later, if any.
 - 19) Time schedule for deferred or seasonal TAB work, if specified.
 - 20) False loading of systems to complete TAB work, if specified.
 - 21) Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - 22) Interstitial cavity differential pressure measurements and calculations, if specified.
 - 23) Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - 24) Procedures for formal progress reports, including scope and frequency.
 - 25) Procedures for formal deficiency reports, including scope, frequency and distribution.
3. Field Logs: Submit at least twice a week to the Commissioning Authority.
 4. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
 5. Progress Reports.
 6. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - a. Submit under provisions of Section 014000.
 - b. Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
 - c. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - d. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - e. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

- f. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
- g. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
- h. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
- i. Include the following on the title page of each report:
 - 1) Name of Testing, Adjusting, and Balancing Agency.
 - 2) Address of Testing, Adjusting, and Balancing Agency.
 - 3) Telephone number of Testing, Adjusting, and Balancing Agency.
 - 4) Project name.
 - 5) Project location.
 - 6) Project Architect.
 - 7) Project Engineer.
 - 8) Project Contractor.
 - 9) Project altitude.
 - 10) Report date.

B. Record Documents

- 1. Record actual locations of flow measuring stations and balancing valves and rough setting.

1.03 TESTING, ADJUSTMENT, AND BALANCING OF AIR SYSTEMS.

1.04 TESTING, ADJUSTMENT, AND BALANCING OF HYDRONIC, STEAM, AND REFRIGERATING SYSTEMS.

1.05 FIELD QUALITY-CONTROL TESTING OF LABORATORY FUME HOODS.

1.06 MEASUREMENT OF FINAL OPERATING CONDITION OF HVAC SYSTEMS.

1.07 SOUND MEASUREMENT OF EQUIPMENT OPERATING CONDITIONS.

1.08 VIBRATION MEASUREMENT OF EQUIPMENT OPERATING CONDITIONS.

1.09 COMMISSIONING ACTIVITIES.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.

6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.
- D. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- E. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- F. Provide additional balancing devices as required.
- G. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- H. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- I. Hydronic Systems: Adjust to within plus or minus 10 percent of design.
- J. Field Logs: Maintain written logs including:
1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- K. Ensure recorded data represents actual measured or observed conditions.
- L. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- M. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- N. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- O. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- P. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- Q. Check and adjust systems approximately six months after final acceptance and submit report.

3.02 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. SMACNA (TAB).
 - 4. Maintain at least one copy of the standard to be used at project site at all times.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.
- F. TAB Supervisor Qualifications: Professional Engineer licensed in the State in which the Project is located.

3.03 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.04 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.05 COMMISSIONING

- A. See Sections 019113 - General Commissioning Requirements and 230800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for ____ percent of the air handlers plus a random sample equivalent to ____ percent of the final TAB report data as directed by Commissioning Authority.

1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 2. Use the same test instruments as used in the original TAB work.
 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F.
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.
- G. No seasonal tests are required.
- H. No further monitoring is required.
- I. No deferred testing is required.

3.06 SCOPE

- A. Test, adjust, and balance the following:
1. Steam Condensate Pumps.
 2. HVAC Pumps.
 3. Air Coils.
 4. Evaporative Humidifier.
 5. Terminal Heat Transfer Units.
 6. Air Handling Units.
 7. Fans.

8. Air Filters.
9. Air Terminal Units.
10. Air Inlets and Outlets.

3.07 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Service factor.
7. Starter size, rating, heater elements.
8. Sheave Make/Size/Bore.

B. V-Belt Drives:

1. Identification/location.
2. Required driven RPM.
3. Driven sheave, diameter and RPM.
4. Belt, size and quantity.
5. Motor sheave diameter and RPM.
6. Center to center distance, maximum, minimum, and actual.

C. Pumps:

1. Identification/number.
2. Manufacturer.
3. Size/model.
4. Impeller.
5. Service.
6. Design flow rate, pressure drop, BHP.
7. Actual flow rate, pressure drop, BHP.
8. Discharge pressure.
9. Suction pressure.
10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

D. Cooling Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Water flow, design and actual.

11. Water pressure drop, design and actual.
 12. Entering water temperature, design and actual.
 13. Leaving water temperature, design and actual.
 14. Saturated suction temperature, design and actual.
 15. Air pressure drop, design and actual.
- E. Heating Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- F. Return Air/Outside Air:
1. Identification/location.
 2. Design air flow.
 3. Actual air flow.
 4. Design return air flow.
 5. Actual return air flow.
 6. Design outside air flow.
 7. Actual outside air flow.
 8. Return air temperature.
 9. Outside air temperature.
 10. Required mixed air temperature.
 11. Actual mixed air temperature.
 12. Design outside/return air ratio.
 13. Actual outside/return air ratio.
- G. Exhaust Fans:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Air flow, specified and actual.
 6. Total static pressure (total external), specified and actual.
 7. Inlet pressure.
 8. Discharge pressure.
 9. Sheave Make/Size/Bore.
 10. Number of Belts/Make/Size.
 11. Fan RPM.
- H. Duct Traverses:

1. System zone/branch.
 2. Duct size.
 3. Area.
 4. Design velocity.
 5. Design air flow.
 6. Test velocity.
 7. Test air flow.
 8. Duct static pressure.
 9. Air temperature.
 10. Air correction factor.
- I. Duct Leak Tests:
1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.
 8. Test orifice differential pressure.
 9. Leakage.
- J. Flow Measuring Stations:
1. Identification/number.
 2. Location.
 3. Size.
 4. Manufacturer.
 5. Model number.
 6. Serial number.
 7. Design Flow rate.
 8. Design pressure drop.
 9. Actual/final pressure drop.
 10. Actual/final flow rate.
 11. Station calibrated setting.
- K. Terminal Unit Data:
1. Manufacturer.
 2. Type, constant, variable, single, dual duct.
 3. Identification/number.
 4. Location.
 5. Model number.
 6. Size.
 7. Minimum static pressure.
 8. Minimum design air flow.
 9. Maximum design air flow.

10. Maximum actual air flow.
 11. Inlet static pressure.
- L. Air Distribution Tests:
1. Air terminal number.
 2. Room number/location.
 3. Terminal type.
 4. Terminal size.
 5. Area factor.
 6. Design velocity.
 7. Design air flow.
 8. Test (final) velocity.
 9. Test (final) air flow.
 10. Percent of design air flow.
- M. Sound Level Reports:
1. Location.
 2. Octave bands - equipment off.
 3. Octave bands - equipment on.
- N. Vibration Tests:
1. Location of points:
 - a. Fan bearing, drive end.
 - b. Fan bearing, opposite end.
 - c. Motor bearing, center (if applicable).
 - d. Motor bearing, drive end.
 - e. Motor bearing, opposite end.
 - f. Casing (bottom or top).
 - g. Casing (side).
 - h. Duct after flexible connection (discharge).
 - i. Duct after flexible connection (suction).
 2. Test readings:
 - a. Horizontal, velocity and displacement.
 - b. Vertical, velocity and displacement.
 - c. Axial, velocity and displacement.
 3. Normally acceptable readings, velocity and acceleration.
 4. Unusual conditions at time of test.
 5. Vibration source (if non-complying).

SECTION 230713
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 078400 - Firestopping.
- C. Section 230553 - Identification for HVAC Piping and Equipment.
- D. Section 233100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. {RSTEMP#2158}UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.{CH#81786}.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or {\rs\#1}.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. Knauf Insulation; Performance+ Duct Wrap: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.

2.03 JACKETING AND ACCESSORIES

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
 - 1. Lagging Adhesive:
 - a. Manufacturers:
 - 1) Design Polymeric; DP 3050 Water Based, Premium Quality, Lagging Adhesive, and Vapor Retarder: www.designpoly.com/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test ductwork for design pressure prior to applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

- D. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

3.03 SCHEDULES

- A. Exhaust Ducts Within 10 ft of Exterior Openings:
- B. Plenums:
- C. Supply Ducts:
- D. Supply Ducts From Fans to Vertical Ducts in Shafts (Cooling System):
- E. Supply Ducts in Vertical Shafts (Cooling Systems):
- F. Supply ducts After Terminal Boxes:
- G. Return and Relief Ducts in Mechanical Rooms:

SECTION 230716
HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment insulation.

1.02 RELATED REQUIREMENTS

- A. Section 230553 - Identification for HVAC Piping and Equipment.
- B. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 232114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

- A. {RSTEMP#678}ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus{CH#127093}.
- B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- C. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- F. {RSTEMP#2158}UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.{CH#127139}.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or {rs#1}.

2.02 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation; Earthwool Insulation Board: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 - 1. K Value: 0.25 at 75 degrees F, when tested in accordance with {RS#678} or ASTM C518.
 - 2. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - 3. Maximum Density: 8.0 pcf.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that equipment has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated equipment containing fluids below ambient temperature; insulate entire system.
- G. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.
- H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- J. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- K. Inserts and Shields:
 - 1. Application: Equipment 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between hangers and inserts.
 - 3. Insert Location: Between support shield and equipment and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
- L. Finish insulation at supports, protrusions, and interruptions.
- M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.
- N. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
- O. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- P. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Pump Bodies:
- B. Cooling Systems:
 - 1. Pump Bodies:

SECTION 230719
HVAC PIPING INSULATION

PART 1 GENERAL

- A. Glass Fiber, Rigid.
- B. Jacketing and Accessories.
- C. Accessories.
- D. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- E. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 232213 - Steam and Condensate Heating Piping: Placement of hangers and hanger inserts.

1.03 SUBMITTALS

- A. Action Submittals

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 SUMMARY DESCRIPTION

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jacketing and accessories.

1.07 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.

- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
- B. All insulation shall meet ASTM, NFPA and UL standards.
- C. Piping insulation thickness shall meet current IECC requirements, based on pipe size and fluid temperature.

2.02 GENERAL REQUIREMENTS

- A. Pipe Fittings and valves shall be insulated with pre-molded type insulation.

2.03 GLASS FIBER, RIGID

- A. Manufacturers:
 - 1. CertainTeed Corporation; : www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. K Value: {RS#678}, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with {RS#1159} of 0.02 perm-inches.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.04 JACKETING AND ACCESSORIES

- A. Aluminum Jacket:
 - 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 - 2. Thickness: 0.016 inch sheet.
 - 3. Type: Factory-applied, self-adhesive jacketing.
 - 4. Finish: Smooth.
 - 5. Joining: Longitudinal slip joints and 2 inch laps.
 - 6. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
 - 7. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.05 ACCESSORIES

A. General Requirements:

1. Provide required accessories in accordance with and subject to the recommendations of the insulation manufacturer.
2. Supply materials that are asbestos free.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 SCHEDULE

A. Heating Systems:

1. Heating Water Supply and Return:
2. Low Pressure Steam Piping:
3. Low Pressure Steam Condensate:
4. Pumped Steam Condensate:

B. Cooling Systems:

1. Chilled Water:

C. Other Systems:

1. Humidifier Piping:

SECTION 230900

COMMON WORK RESULTS FOR HVAC CONTROL

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Common work results for HVAC Control, comprising Instrumentation and Controls for HVAC, a Direct Digital Control System for HVAC, and an Integrated Automation System.
- B. Related Requirements
 - 1. Drawings and general provisions of the Contract, including the General Conditions and Supplementary Conditions apply to this section.
 - 2. Division 01 Specification Section
 - 3. HVAC Control Sections:
 - a. Section 23 09 13 – Instrumentation and Control Devices for HVAC
 - 1) Input devices, output devices, control valves, control dampers
 - b. Section 23 09 23 – Direct-Digital Control System for HVAC
 - 1) DDC networks, DDC controllers, DDC software
 - c. Section 23 09 63 – Integrated Automation
 - 1) BAS computer hardware, BAS software
- C. System Description
 - 1. Provide a complete and operational system, comprised of Instrumentation and Controls specified under 23 09 13 connected to Direct Digital Controllers specified under 23 09 23 which carry out Sequences of Operation specified under 23 09 93, with a BAS specified under 23 09 63 integrated to all DDC as well as other sub-systems to provide supervisory control, user interface, trending, alarming, and other software modules. The Common Work Results for HVAC Control under This Section shall apply to the Work under each other related section.
 - 2. Provide minor items, accessories, devices, or program features reasonably inferable as necessary, to the complete and proper installation and operation of any system, whether or not they are specifically called for by these specifications or drawings.
 - 3. Provide UUKL864 smoke control, consisting of interfaces to the Fire Alarm System, control of mechanical equipment, and feedback of operating status of all equipment to the Fire Alarm System.
- D. Performance Requirements
 - 1. Graphic Response Time: display each completed graphic with the latest real-time point values within fifteen seconds of command - it shall be possible to toggle between multiple graphics within 15 seconds each.
 - 2. Alarm Response Time:
 - a. Critical alarms shall report to the operator workstation within 5 seconds
 - b. Priority alarms shall report to the operator workstation within 10 seconds
 - c. Non-critical alarms shall report to the operator workstation within 15 seconds.
 - 3. Control Stability:

- a. Temperature Control Stability – Space Temperature: stable ($\pm 0.5^{\circ}\text{C}$ deviation per 5 minutes at steady state) and at setpoint (within $\pm 1.0^{\circ}\text{C}$ of the set point with dead band) within 15 minutes of a set point change.
- b. Temperature Control Stability – AHU Discharge: stable ($\pm 0.1^{\circ}\text{C}$ deviation per 5 minutes at steady state) and at set point (within $\pm 0.5^{\circ}\text{C}$ of the set point) within 5 minutes of a set point change.
- c. Temperature Control Stability – Chilled Water: stable ($\pm 0.2^{\circ}\text{C}$ deviation per 5 minutes at steady state) and at set point (within $\pm 0.5^{\circ}\text{C}$ of the set point) within 5 minutes of a set point change.
- d. Humidity Control Stability – AHU Discharge: stable ($\pm 3\%\text{RH}$ deviation per 5 minutes at steady state) and at set point (within $\pm 3\%\text{RH}$ of the set point) within 5 minutes of a set point change.
- e. Duct Static Pressure Control Stability: stable ($\pm 25\text{ Pa}$ deviation per 5 minutes at steady state) and at set point ($\pm 50\text{ Pa}$ of the set point) within 5 minutes of a set point change.
- f. Water Differential Pressure Control Stability: stable ($\pm 0\text{ psi}$ deviation per 5 minutes at steady state) and at set point ($\pm 3\text{ kPa}$ of the set point) within 5 minutes of a set point change.

1.02 REFERENCES

A. Abbreviations and Acronyms

1. Building Automation System
2. Commissioning Authority
3. Direct-Digital Controls
4. Operator Workstation Definitions

B. Reference Standards

- a. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- b. UL 916 - Energy Management Equipment.
2. Work shall comply with the indicated reference standards and codes, or the relevant British Standard, or the applicable standards and codes of the Authority Having Jurisdiction, whichever is the most stringent.
 - a. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
 - b. ANSI/ASHRAE Standard 135-2001, BACnet.
 - c. Uniform Building Code (UBC), including local amendments.
 - d. UL 916 Underwriters Laboratories Standard for Energy Management Equipment.
 - e. National Electrical Code (NEC).

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. After examining all drawings and documents pertaining to the Work on this project, obtain written clarification to any questions concerning the nature, extent, or intent of the Work. Written clarification shall precede submission of a project bid and technical proposal.
2. Ensure that all materials and components which interact with work by others are compatible, in order to provide a "Complete, Operating, and Functional" control system as specified under This Section.
3. Where equipment or systems specified under other Sections of these Specifications connects to the Work of this Section, provide proper connection(s) to such equipment including all necessary trade and technical coordination.

4. Coordinate the location and size of pipes, equipment, fixtures, conduit, ducts, openings, switches, outlets, etc., in order that there may be no interferences between the installation or progress of the work of any Trade Contractor on the project due to work performed under this Section.
5. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
6. Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
7. Coordinate electrical requirements for all equipment requiring power. The Electrical Work is specified in Division 26.

1.04 SUBMITTALS

A. General:

1. Provide submittals and comply with procedures in accordance with Division 01 Submittal Procedures requirements
2. Gather information from suppliers, manufacturers, and installers for all equipment furnished or installed under other Sections, when interface or connection to equipment is provided under this Section
3. Verify site conditions and gather field data necessary for preparation of accurate submittals

B. Submittal Index:

1. Provide a complete submittal index of all submitted items, with fields for description, specification section, submittal package / ID, and page number for each item
2. With the first submittal package, provide complete index, with proposed grouping into subsequent packages indicated in the submittal package field
3. Update and amend submittal index with each subsequent submittal package
4. Include the complete index with every submittal package, and indicate the items included in that specific package by bold or colored font in index

C. Product Data:

1. Data Sheet Index:
 - a. Provide sub-index of product data sheets, with fields for description, specification section, submittal package / ID, and page number for each item
2. Manufacturer's Technical Data Sheets:
 - a. For every product furnished
 - b. Indicate specification section and complete model or part number on each data sheet
 - c. Clearly indicate the specific device selected, applicable options, selected ranges, etc. on each data sheet
3. Manufacturer's Software Manuals:
 - a. For each software product furnished or employed during installation

D. Riser Diagrams:

1. For each BAS network subnet, showing all connected devices, such as DDC controllers, integrated automation hardware, network infrastructure devices (switches, routers, repeaters)
2. Indicate manufacturer's part numbers for each device
3. Indicate the specific equipment / system served by each device

E. Flow Diagrams:

1. For each specific equipment / system served by each DDC controller
 2. Include systems, equipment, and devices provided or furnished under this Section, as well as under other Sections and Divisions, in order to completely illustrate the extents and contents of the specific equipment / system served
 3. Schematically indicate all relevant equipment; the relationships between equipment formed by piping, ductwork, or wiring; the direction of flow when applicable; and the boundaries of the system
 4. Relevant system equipment includes any device or sub-system identified in a Points Matrix or Sequence of Operation, or otherwise required for complete understanding of system function under a Sequence of Operation
 5. Indicate all instrumentation and control devices, such as sensors and actuators, and all direct hardwired interfaces to other equipment, with the following information for each point:
 - a. Device ID / Equipment Tag
 - b. Point Software Name
 - c. Point Type (i.e. AI, AO, BI, BO)
 - d. Controller terminal number
 - e. Wiring termination type
 6. Indicate all data connection interfaces to other equipment, with the following information for each device:
 - a. Device ID / Equipment Tag
 - b. ID of connected network
 - c. Device Network Address
 - d. Point Software Name(s), or reference to separate Points List
 - e. Network wiring termination type
- F. Point Schedules:
1. Identify each input and output for each DDC controller, including points in use as well as all spare / unused points, including the following information for each:
 - a. Device ID
 - b. Point Type
 - c. Point Number (according to DDC controller numbering scheme)
 - d. Point Software Name
 - e. Point Description
- G. Sequences of Operation:
1. For each specific equipment / system served by each DDC controller
 2. Submitted sequences of operation shall be the result of the detailed analysis necessary to create actual controller programming which achieves the design sequence of operation, in a format compatible with the programming language used
 3. Submitted sequences of operation shall incorporate additional minor and incidental software functions beyond those specified in the design sequence of operation, in order to create a fully functional system which attempts to maximize equipment life, prevent operator error, and minimize energy consumption, e.g. minimum on/off time delays, setpoint adjustment high and low limits, maximum ramping rates of change for analog outputs and control loops.
 4. Acceptable formats include plain English text, and annotated graphical / object-based / flow-chart type formats
 5. Naming Convention:
 - a. Include plain English descriptions, sufficient to permit a reader to relate each program element to corresponding portions of the design sequence of operation

- b. Utilize identifiers (such as device ID, equipment tag, and point software names) consistent with other submittal documents, to permit a reader to relate each program element to corresponding submitted Flow Diagrams, Point Schedules, Bill of Materials, etc.
 6. Include all virtual and real points, setpoints, overrides, variables, constants, PID loops, reset blocks, switches, timers, high/low selectors, alarms, alarm setpoints, alarm limits, proofing modules, staging blocks, etc. to fully describe the sequence of operation
 7. Provide default values for all setpoints, limits, alarm settings, time delays, and other operator adjustable parameters
- H. Graphics
1. Screen shots of all graphic pages including floor plans, system flow diagrams, tables, schedules, integration points, etc.
- I. Panel Construction Diagrams:
1. For each specific control panel, including each DDC controller
 2. Indicate interior physical arrangement of panel and all component parts, including DDC controllers, expansion modules, terminal strips, wire raceway, disconnect switches, fuses, transformers, power supplies, accessory items, etc.
- J. Bill of Materials:
1. Identify every part provided to the project, including the following information for each:
 - a. Device ID
 - b. Manufacturer
 - c. Complete Model Number / Part Number, including all options and specifications
 - d. Quantity
 - e. Serial Number (to be completed for Record Documentation)
 - f. Measurement Range / Output Range
 - g. Description
 2. Individually list each instance of a product which is provided with a manufacturer serial number, or which will be provided with another unique identifier such as a network address, device ID, or equipment tag
 3. Products without any unique identifier may be grouped together and assigned quantities
 4. Provide Bill of Materials for each Panel Construction Diagram, Flow Diagram, and Riser Diagram.
- K. Wiring Diagrams
1. Wiring termination detail for each typical instrumentation and control device
 2. Wiring termination detail for each direct hardwired interface to other equipment, such as variable frequency drives and motor starters
 3. Wiring termination detail for each typical network type
 4. Wiring termination detail for each unique or non-typical interface
 5. Wiring interface detail to each device provided under other Sections and Divisions
 6. Cable and wire color scheme, indicating jacket and insulation color standards for each wire type
- L. Floor Plan Drawings
1. For each building level and area with BAS equipment
 2. Indicate the location of each BAS device, system, or equipment, including the following:
 - a. Local control panels, terminal unit controllers, and other digital controllers

- b. Instrumentation and control devices located outside of electrical or mechanical rooms (except for devices serving terminal unit controllers which are visible from and accessible from the terminal unit controller location)
 - c. Network infrastructure devices, such as switches, gateways, routers, and repeaters
 - d. Integrated automation hardware, such as application servers and operator workstations
 - e. Wire pathways, such as conduits, raceway, cable basket, cable tray, trunking, and cable hangers
3. Indicate the location of each BAS device visible from the occupied space, such as space temperature sensors, thermostats, occupancy sensors, occupant interface devices such as touchpanels and switches.

1.05 CLOSEOUT SUBMITTALS

A. General

- 1. Comply with applicable portions of Division 01, and the additional requirements of This Article.

B. Operation and Maintenance Manual

- 1. General Requirements:
 - a. On-line Access: in addition to submittal requirements of Division 01, provide electronic copies of all Operation and Maintenance Manual sections in PDF format, and file electronically within BAS for web browser-based on-line access by any BAS user.
 - b. All manufacturer literature shall be original published matter – photocopies, printouts from websites, or other non-original reproductions are not acceptable.
- 2. Instrumentation and Controls Manual: include the following documentation:
 - a. Table of Contents
 - b. General description and cut sheets for all components.
 - c. Detailed wiring and installation instructions and complete calibration procedures for each device.
 - d. Maintenance Instructions: Document all maintenance and repair / replacement procedures. Provide ordering number for each system component, and source of supply. Provide a list of recommended spare parts needed to minimize downtime.
- 3. DDC Hardware Manual: include the following documentation:
 - a. Table of Contents
 - b. General description and cut sheets for all components.
 - c. Detailed wiring and installation illustrations for each controller and panel device.
 - d. Complete trouble-shooting procedures and guidelines.
 - e. Complete operating instructions for all systems.
 - f. Maintenance Instructions: Document all maintenance and repair / replacement procedures. Provide ordering number for each system component, and source of supply. Provide a list of recommended spare parts needed to minimize downtime.
- 4. DDC Software Manual: include the following documentation:
 - a. Table of Contents.
 - b. Sequence of Operations.
 - c. Program Function Index.
 - d. Program Listing of Software Source Code OR Flow Chart Diagrams of Programming Objects. For control systems using either compiled program code or interpreted code provide source code of all programs and function libraries to be installed. For systems using a graphical object orientated programming environment, provide a

- computer plotted flow chart showing the interconnection of the programming objects and all associated parameters.
 - e. Printed listing of controller database files.
 - f. Appendix A: Alphabetical Software Point Name Abbreviation List. Include Name, Description, Controller Where Located, Point Type and Point ID.
 - g. Appendix B: Alphabetical I/O Point List. Include Point Name, Controller Location, Point Number, Control Device, Range and Span.
 - h. Alphabetical Index of all DDC point names with documentation manual page number references.
5. Manufacturer's Manuals: include copies of all manufacturer's manuals covering the installed system, including the following at minimum:
- a. System Engineering Manual.
 - b. System Installation Manual.
 - c. Programming Manual.
 - d. Engineering and Troubleshooting Bulletins.
 - e. Operator Workstation Software Manual.
 - f. All other pertinent manuals published by the control system manufacturer.
- C. Warranty Documentation
- 1. Obtain and assemble executed certificates, warranties, bonds, receipts for extra stock, permits signed by any authorities having jurisdiction, and any required service and maintenance contracts from the respective manufacturers, suppliers, and Subcontractors.
 - 2. Verify that documents are in proper form and contain full information.
 - 3. Provide Table of Contents neatly typed, in complete and orderly sequence. Include complete information for each of the following:
 - a. Product or work item
 - b. Firm, with name of principal, address, and telephone number
 - c. Scope
 - d. Date of beginning of warranty or service and maintenance contract
 - e. Duration of warranty or service maintenance contract
 - f. Proper procedure in case of failure
 - g. Instances which might affect validity of warranty or bond
 - h. Contractor, name or responsible principal, address, and telephone number
- D. Record Documentation
- 1. Updated Submittals: include all submittal documents and drawings, updated to reflect the actual installation.
 - 2. Record Drawings: a clean, undamaged set of Contract Drawings including coordination drawings and shop drawings, marked clearly and legibly to show the following:
 - a. Actual installation where the installation varies substantially from the Work as originally shown.
 - b. Actual installed routing of all BAS communication networks
 - c. Actual installed location of every DDC and BAS controller, panel, and system device
 - d. Actual installed location of every Instrumentation and Control device located in a different room than a panel-mounted parent DDC controller, giving particular attention to devices installed in concealed locations that would be difficult to locate at a later date. Examples include remote pressure sensors, outdoor sensors, remote relays and contactors.
 - e. Actual installed location of every Instrumentation and Control device located above the ceiling in a finished space, giving particular attention to devices not visible from the location of the parent DDC terminal unit controller (whether accessible from

ground or by ladder). Examples include remote valves, remote dampers, duct temperature sensors.

3. Control Panel Drawings: place updated drawings and diagrams in each local control panel of each mechanical room, including panel construction drawing, wiring diagram, system flow diagram, and controller points list

1.06 QUALITY ASSURANCE

A. Contractor Experience

1. All systems shall be designed, installed, commissioned, and serviced by manufacturer authorized contractor ("The Contractor") and factory trained personnel.
2. The Contractor shall have an in-place support facility within 150 km of the site with technical staff, spare parts inventory, and necessary test and diagnostic equipment.
3. The Contractor staffed with qualified service personnel, fully capable of providing instructions as well as routine and emergency maintenance service on all system components.
4. The Contractor shall have emergency service available on a 24 hour, 7 day a week basis
5. The Contractor shall provide full-time, on-site, experienced project manager for this work, responsible for direct supervision of the design, installation, start-up and commissioning of all systems.
6. The Contractor shall be regularly engaged in the design, installation and maintenance of similar systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of systems similar in size and complexity to this project.
7. The Contractor shall provide a list of at least 10 projects, similar in size and scope to this project completed within the past 3 years.
8. The Contractor shall employ factory trained personnel who are specialists in the activities required for this project including: Project Management, Engineering, Programming, Field Supervision Installation, Quality Assurance, Interface Design, and Start-Up
 - a. The project manager, lead software programmer, and quality assurance manager shall each have a minimum 8 years of industry experience and 5 years of experience with the specific system to be installed on this project under their responsibility.
 - b. The project application engineer and any assistant managers shall each have a minimum 5 years of industry experience and 3 years of experience with the specific system to be installed on this project under their responsibility.
 - c. Other individuals shall each have a minimum 2 years of industry experience and 2 years of experience with the specific system to be installed on this project under their responsibility, and shall take direction from the individuals listed above.

B. Products

1. Materials and equipment shall be the cataloged products of manufacturers regularly engaged in the production of Instrumentation and Controls, Direct Digital Control Systems, and Building Automation Systems for the HVAC industry.
2. Materials and equipment shall be the manufacturer's latest standard design that complies with the specification requirements. Prototypes, Beta or other non-standard or non-cataloged product offerings are not acceptable.
3. Where two or more units of the same material or equipment are required, these units shall be the products of a single manufacturer; however, the component parts of the system need not be the products of a single manufacturer.
4. Each component product shall have the manufacturer's name, city, model and serial number (if available) permanently attached on the product.
5. Substitutions

- a. This specification contains references to specific manufacturers and products. These references are to establish a standard of quality and capability for each item and are not intended to limit or exclude other products which are of comparable quality and capability.
- b. Proposed substitutions shall comply with the requirements of Division 01 Substitutions, and the following additional requirements:
 - 1) The substitution proposal shall include a submittal with all technical data, physical samples, independent test results (UL, CSA, etc.), lists of installed sites, product demonstrations, and other information as may be requested by the Owner/Engineer, to allow for a "Head-To-Head" comparison with the established standards of quality.
 - 2) The substitution submittal shall also include a detailed technical comparison of the proposed item with one of those listed as an acceptable quality standard.
 - 3) Prototypes of items shall not be accepted for evaluation. Only items in current regular production shall be evaluated.
 - 4) Evaluations shall be based on all features, benefits and capabilities, not just those specifically identified within this specification. The judgment of the Owner/Engineer shall be final.
 - 5) Provide bid price for the specified base bid system, with proposed substitutions priced as additive or deduct alternates.

1.07 WARRANTY

A. Vendor Warranty

1. The Work under This Section shall be free from defects in material and workmanship under normal use and maintenance for a period of twelve (12) months
2. Provide parts and labor warranty for the period for all products and work provided under This Section, at no cost to the Owner
3. Provide labor warranty for the period for all products installed but not furnished under this Section, at no cost to the Owner
4. Provide parts warranty for the period for all products furnished but not installed under this Section, at no cost to the Owner
5. Initial Notification: Made by telephone, SMS, or email, to number / account with 24 x 7 x 365 monitoring and emergency dispatch capability, any defect must be reported within thirty (30) days of occurrence
6. Normal Warranty Service:
 - a. Definition: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control
 - b. Call-Back Time: Response by telephone within eight (8) normal business hours of initial notification
 - c. Dispatch Time: In the event that correction is not possible by telephone, at least one (1) service technician trained and competent in the system to be serviced shall be dispatched to the site within three (3) normal business days of initial notification
7. Emergency Warranty Service:
 - a. Definition: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control
 - b. Call-Back Time: Response by telephone within two (2) hours of initial notification, 24 hours per day, 7 days per week, and 365 days per year
 - c. Dispatch Time: In the event that correction is not possible by telephone, at least one (1) service technician trained and competent in the system to be serviced shall be

dispatched to the site within four (4) hours of initial notification, 24 hours per day, 7 days per week, and 365 days per year

8. Free Technical Support:
 - a. Provide unlimited technical support by telephone, during normal business hours, throughout the warranty period, at no cost to the Owner.

PART 2 PRODUCTS

2.01 LOCAL CONTROL PANELS

- A. General:
 1. Local Control Panels house DDC controllers, including Building Controllers (B-BC), Advanced Application Controllers (B-AAC), and Application Specific Controllers (B-ASC).
 2. B-ASC for terminal units such as VAV and FPB may be housed in Local Control Panels, but are typically installed in enclosures integral to the parent mechanical equipment.
 3. All panels with key locks shall be keyed the same.
 4. All panels shall be UL listed.
- B. Door Requirements:
 1. MEP Equipment Rooms with Secured Access
 - a. Key locked latch, all panels keyed the same
 2. Above Ceiling:
 - a. Fastened by screws
 3. Other Locations
 - a. Key locked latch, all panels keyed the same
- C. Panel Construction:
 1. Outdoor Locations / Other Wet Locations:
 - a. Rating: NEMA EN 10250 Type 4 (IP66)
 - b. Construction: 16-gauge 304 stainless steel, welded seams, hinged gasketed door with hidden hinges, quarter-turn key-locked handle with multi-point interior latch
 2. Above Ceiling:
 - a. Rating: Chicago Plenum
 - b. Construction: metal, no holes or openings, gasketed cover/door fastened by screws
 3. MEP Equipment Rooms / Other Locations Subject to Dust / Parking Structures Not Subject to Rain:
 - a. Rating: NEMA EN 10250 Type 4 (IP52)
 - b. Construction: 16-gauge painted steel, welded seams, hinged gasketed door with hidden hinges, quarter-turn key-locked handle with multi-point interior latch
 4. All Other Clean Indoor Locations
 - a. Rating: NEMA EN 10250 Type 1 (IP10)
 - b. Construction: 16-gauge painted steel, hinged door, key-locked latch
- D. Interior Requirements:
 1. Provided with removable perforated backplane
 2. Provided with plan pocket on inside of door
 3. Provide terminal strip with marking pad for each terminal, for all field wiring and power wiring entering panel
 4. Provide DIN rail, mounted by screw to the removable backplane, for mounting all devices with available DIN rail mounting option

5. Provide plug-in type relay socket for each relay
- E. Power Requirements:
 1. All devices within the panel shall be UL916 or CSA listed
 2. Segregate Class 1 and Class 2 wiring and devices within local control panels as required by code and the AHJ. Provide separate enclosures, or barriers and covers, within local control panels as necessary.
 3. Provide one fused disconnect switch for each low voltage power circuit entering panel, fuse sized appropriately for all connected transformers, power supplies, and sockets
 4. Provide one un-switched convenience electrical power socket within the panel for technician laptop, separately fused appropriately
 5. Provide transformers with manual-reset secondary circuit breakers
 6. Provide power supplies with fused over-current protection
 7. Provide separate replaceable fuse, appropriately sized, for each controller, unless controller is protected by integral replaceable fuse.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and surfaces to receive equipment for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Notify the Architect/Engineer of any conflicts in Drawings, Specifications or approved shop drawings prior to proceeding with installation.
- D. Verify that all equipment, including fittings and accessories, for installation into chilled water piping is suitably rated for the worst-case absolute and differential pressure at that point in the system and is compatible for installation into the chilled water piping.

3.02 INSTALLATION

- A. General
 1. Provide all labor, materials, tools, scaffolding, machinery, equipment, appliances and services necessary to complete the Work under This Section. All systems and equipment shall be complete in every respect and all items of material, equipment and labor shall be furnished and installed for a fully operational system. Coordinate the Work under This Section with the Work under Other Sections so as to resolve conflicts without impeding job progress or the Schedule. Provide notice with the bid proposal of any concrete Work required by this Division that is not indicated on the Structural, Architectural, Mechanical or Electrical Drawings.
 2. Examine all the Architectural, Structural, and Facility Services (Divisions 21-28) drawings, and other Divisions and sections of the Specifications in order to determine the extent of Work required to be completed under this Division. Failure to examine all the Contract Documents for this Project will not relieve the responsibility to perform all the Work required for a complete, fully operational and satisfactory installation.
 3. Do not rig, tie to, or rest weight upon any part of the building or make use of any stairway until specific permission is obtained.
 - a. Permission to rig to or make use of any part of the building premises shall not relieve the responsibility for any damage.

4. Drawing plans, schematics, and diagrams indicate general location and arrangement of the Work. Determine exact locations necessary to secure the best conditions and results.
5. Install wiring and containment at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install wiring and containment above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Install equipment to permit servicing.
8. Select system components with pressure rating equal to or greater than system operating pressure.
9. Select system components with ambient temperature and humidity requirements suitable for their locations.
10. Refer to Division 07 Section Penetration Firestopping for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
11. Refer to Division 26 specifications for sleeve requirements when wiring and containment pass through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
12. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
13. Install all equipment and devices according to manufacturer's written installation procedures.

B. Low Voltage Electrical Wiring:

1. Provide low voltage control system wiring and raceway necessary to form a complete and operational system, including the following:
 - a. Power circuits from the circuit breaker to DDC and BAS devices and panels requiring low voltage power, including terminations at each end
 - b. Low voltage control power to large valve and damper actuators, including terminations at each end
2. Definition: Circuits with a potential in the range 50-600 VAC, typically the circuits delivering power to equipment and sockets within a building.
3. Scope of Installation: Provide all raceway, supports, wiring, accessories and wiring connections required to support the Work under This Section, from the source circuit breaker, unless noted otherwise
4. Raceway Requirement: All low voltage electrical wiring shall be installed in enclosed raceway
5. Provide connection to circuit breakers in Normal, Emergency, Standby, and UPS-backed panels as noted, or required by application if not noted
6. All low voltage electrical wiring shall comply with the product and installation requirements of applicable portions of Division 26 and all local and national electric codes
7. Label each piece of equipment, device, and socket receiving low voltage electrical power with the source electrical panel and circuit breaker designation
8. Label each source electrical panel circuit breaker with the identification of each connected piece of equipment, device, and socket
9. Provide a dedicated low voltage circuit (minimum) for each local control panel and its contents

C. Extra-Low Voltage Control System Wiring

1. Provide extra-low voltage control system wiring and raceway necessary to form a complete and operational system, including the following:
 - a. DDC second and third tier network wiring, both horizontal and vertical, including all terminations

- b. DDC first tier network wiring to Building Systems Ethernet Network point of demarcation, including all required outlets, patch cables, and terminations
 - c. DDC control power wiring from transformers and power supplies to all end devices receiving power
 - d. DDC input and output point wiring for all input devices, output devices, control valves, and control dampers, including control power wiring to the same devices
 - e. DDC input, output, and data connection wiring to the terminals of motor starters and VFDs, such as start/stop relays, thermostats.
 - f. Safety interlock wiring between safety switches (such as pressure switches, fire alarm shut-down relays, gas detectors, etc), relays, motor starter safety terminals, VFD safety terminals
 - g. Interlock circuit wiring between devices such as actuator position switches and motor starters or VFDs
 - h. DDC and BAS system data connection wiring to equipment provided under other Sections, complete to the connection port on the equipment and including all terminations, unless noted otherwise
 - i. Intermediate field-installed wiring between elements of sensors, sub-systems, and equipment provided under This Section, including all terminations
2. Definition: circuits with a potential not more than 25V AC RMS, and 35V AC peak, and 60V DC ripple-free, under dry conditions, typically the control system signal circuits (analog and binary points) and digital communications circuits
3. Provide all raceway, supports, wiring, accessories and wiring connections required to support the Work under This Section
4. Raceway Requirements:
 - a. All extra-low voltage control system wiring, regardless of voltage and classification, shall be installed in enclosed raceway, except in accessible ceiling and raised floor cavities with removable tile where allowed by local code
 - b. All extra-low voltage wiring within walls, including wiring to wall mounted sensors, shall be installed in enclosed raceway
 - c. Install extra-low voltage control system wiring in separate raceway from any low voltage wiring and in separate raceway from the wiring of any other systems to the point of interconnection with other systems
 - d. Size enclosed raceway to maintain a maximum 40% fill with wiring
5. All extra-low voltage wiring shall comply with the product and installation requirements of applicable portions of Division 26 and all local and national electric codes
6. Ethernet network wiring (copper and fiber) shall additionally comply with the product and installation of applicable portions of Division 27
7. Wiring not installed in enclosed raceway shall comply with the product and installation requirements of applicable portions of Division 26 and all local and national electric codes
8. Install extra-low voltage wiring according to manufacturer written instructions for maximum cable length, terminations, and shield / drain terminations
9. Digital Communication Wiring Requirements:
 - a. Splicing of communications wiring is prohibited
 - b. "Tee tapping" of communications wiring is prohibited
 - c. Provide a bus or daisy-chain network topology, even if alternate topologies such as free, star, or ring exist
10. Minimum Wire Sizes and Construction
 - a. Comply with the greater of; manufacturer written instructions, local and national electric code minimum requirements, and the following minimum requirements. Where conflict exists, codes shall apply over manufacturer instructions, and manufacturer instructions shall apply over these minimum requirements.

- b. Analog Input Wiring: jacketed shielded twisted pair, minimum 1.0 SQMM stranded conductors
 - c. Binary Input Wiring: jacketed twisted pair, minimum 1.0 SQMM stranded conductors
 - d. Analog Output Wiring: jacketed shielded twisted pair, minimum 1.0 SQMM stranded conductors
 - e. Binary Output Wiring: conform to local and national electrical codes
 - f. 24 VAC Control Power Wiring: conform to local and national electrical codes
 - g. Internal Local Control Panel Wiring: minimum 1.0 SQMM conductors
 - h. Digital Communications Wiring: as required by manufacturer's instructions
11. Cable and Wire Color Standards
- a. Provide colored cables and wires to allow quick identification and trouble shooting of the system.
 - b. Cable jacket and wiring colors shall be consistent throughout the entire system, and for each application listed below. Mixed or changed cable and wire colors shall be removed and replaced at no additional cost.
 - c. Provide a unique jacket color for each of the following cables.
 - 1) Ethernet, different color from other systems on project
 - 2) First tier communication network, if not Ethernet
 - 3) Second tier communication network, different color for each protocol
 - 4) Exposed ELV sensor/actuator cabling
 - 5) Exposed ELV 24 VAC control power cabling

D. Local Control Panels

- 1. Installation
 - a. Mount securely to either a free-standing metal U-channel frame, or to a building wall, in a location not subject to vibration.
 - b. Do not mount onto any equipment, ductwork, fan housings or pipes. Panels shall not be subjected to vibration.
 - c. Mount panels level and plumb in all three axes.
 - d. Install 150mmx150mm (6"x6") metal wire trough with removable cover, within 200mm (8") above and/or below the entire width of each Local Control Panel that is larger than 14000sqmm (576 SqIn).
 - e. Route low voltage and extra-low voltage wiring from the wire trough into the panel through close nipples sized to not exceed 50% fill ratio.
 - f. Route low voltage power wiring into panel through separate conduits from extra-low voltage wiring.
 - g. Exterior Locations: Conduits shall enter into the bottom only of Local Control Panel.
- 2. Interior Construction
 - a. Mount all devices, DIN rail, and wire duct level and plumb, in a neat and organized fashion. Where possible, group similar devices together and align vertically and/or horizontally.
 - b. Route all interior wiring through thermoplastic wire duct sized with a maximum 80% fill ratio. Provide a minimum of two vertical and three horizontal wire ducts within each panel that is larger than 14000sqmm (576SqIn). Provide additional ducts to minimize the distance from the wire duct to the individual devices. Low voltage and extra-low voltage wiring shall not occupy the same duct. Install duct covers upon completion.
 - c. Connect all field wiring entering or leaving panel through terminal strips within the panel. Direct connection of field wiring to panel devices is only acceptable if the panel device is equipped with removable modular plug-in terminal blocks.

- d. Mount all devices to DIN rail when devices are available with DIN rail mounting option. Screw DIN rail to removable backplane. When not available, screw devices directly to removable backplane.
- 3. Control Transformers and Power Accessories
 - a. Mount all transformers or power supplies external to the Local Control Panel. Where control transformers or power supplies are needed to be installed interior to Local Control Panel, EOR approval will be necessary. Provide panels of adequate size to dissipate internal heat and protect components and provide low voltage and extra low voltage separation per NEC.
 - b. Control transformers may be mounted externally in IP10 enclosure to the top of the panel, below the trough and between with conduit nipples.
 - c. All control transformers shall be provided with manual-reset secondary circuit breaker.
 - d. Provide on/off switch for each low voltage power circuit entering the panel, on the primary side of any control transformers and power supplies.
- E. Identification Standards
 - 1. Local Control Panels:
 - a. Exterior: identify all local control panels with a machine-made label or engraved plastic / lamacoid nameplate securely affixed to the outside of the panel enclosure. Nameplate shall include the identification of the system(s) served by the controller and the panel's ID as shown on the control drawings.
 - b. Interior: identify each panel device with a machine-made label securely affixed to the backplane of the panel. Label shall include the identification of the I/O point name and device ID as shown on the control drawings.
 - c. Interior: identify all B-BC, B-AAC, and B-ASC controllers by a machine-made label securely affixed to the controller housing or backplane of the panel. Label shall include the identification of the system(s) served by the controller, and the controller's ID as shown on the control drawings.
 - d. Interior: identify each power circuit, fuse, and switch with a machine-made label securely affixed to the backplane of the panel. Label shall identify the electrical panel and circuit number providing power and the device ID as shown on the control drawings.
 - 2. Other Controllers and Panels:
 - a. Identify all other enclosures above finished ceilings, such as those containing B-ASC and B-AAC serving unitary or terminal unit equipment, by a machine-printed identification label securely affixed to the outside of the controller enclosure in location visible from the ground when ceiling tile is removed or access door is opened. The label shall include the identification of the device ID as shown on the control drawings.
 - b. Identify all other enclosures containing controllers, which are located in concealed areas such as above ceilings or behind access doors, by the application of self-adhesive, blank, color coded, stick-on "dots". Each "dot" shall be located on the access door frame or drop ceiling grid nearest to the controller. The color of the "dots" shall be the same for all controls, and shall be approved by the Owner, prior to application.
 - 3. Field Devices:
 - a. Identify all field devices with a machine-made label securely affixed to the device or a label tag secured to the device by a wire tie or a metal chain tag. Label shall not cover any information on the device. The label shall include the identification of the I/O point name and device ID as shown on the control drawings. Label shall be concealed for devices mounted in the finished space.

- b. The location of each field device installed in concealed areas, such as above ceilings or behind access doors, shall be identified by the application of self-adhesive, blank, color coded, stick-on "dots". Each "dot" shall be located on the access door frame or drop ceiling grid nearest to the field device. The color of the "dots" shall be the same for all field devices, and shall be approved by the Owner, prior to application.
- 4. Raceways:
 - a. Identify all control system raceway by painting the covers of all junction and pull boxes. The color of the covers shall be consistent throughout the entire control raceway system. Coordinate cover paint color to be unique among all other raceway systems such as those provided under Divisions 26, 27, and 28.
 - b. Junction and pull box cover color(s) shall be submitted for review. Approval by the Owner will be required when the Owner already has a color standard in place.
- 5. Wires and Cables:
 - a. Identify all low voltage and extra-low voltage control wiring by number, as referenced to the control drawings, at each end of the conductor or cable. Label shall be machine-printed on specialty wire marker media, securely affixed to the wire jacket. Hand-written labels and labels made on standard label tape are not acceptable. Legibility of text on specialty wire marker media shall not degrade when subjected to handling and flexing.

3.03 INSTALLATION

- A. The base bid BAS shall include control and monitoring of the following:
 - 1. DDC of the following equipment:
 - a. Air handling unit
 - b. Variable air volume units
 - c. Exhaust fans
 - 2. Provide data connections to the following equipment manufacturer's digital controllers and systems. Coordinate with the protocols being furnished by the equipment manufacturers and provide all gateways, routers, and drivers necessary for a complete interface.
 - a. Data connection to all installed:
 - 1) Variable speed drives
 - 2) Mitsubishi mini split
 - 3. Integrated Automation Equipment
 - a. Refer to Section 23 09 63 - Integrated Automation for requirements.
 - 4. Deliverable Requirements.
 - a. Fulfill requirements of the General Conditions.
 - b. Fully participate in all aspects of commissioning the BAS and as specified in; Division 1, Section 01 91 00 (General Commissioning Requirements), Section 01 91 10 (Functional Performance Testing Procedures), and Section 23 08 01 (Energy Management and Control System Commissioning, including timely completion of pre-functional checklists, startup and testing of control components and systems, execution of functional performance and integrated system procedures and prompt resolution of issues identified during the commissioning process.
 - c. Prepare a comprehensive control submittal for review and approval before starting any field work. Meet with Engineer at his office for preliminary review of each submittal package.
 - d. Install controls conforming to these specifications, including Special Conditions listed hereinafter.
 - e. Coordinate with other trade contractors.

- f. Program the sequences of operation, color graphics displays and trend reports for each DDC controller before start-up.
- g. Self commission each DDC controller after start-up.
- h. Install color graphics displays and trend reports for each DDC controller after start-up.
- i. Perform contractor post start-up testing as required hereinafter.
- j. Allow unfettered access for the Commissioning Agent and Engineer to the entire BAS.
- k. Provide comprehensive training of the Owner's operators.
- l. Provide comprehensive as-built documentation for the BAS, including all software programming.
- m. Provide comprehensive Operation and Maintenance manuals for the BAS.
- n. Provide warranty of BAS for the time period identified in the General Conditions. Provide longer warranties for particular components as required within this Section.
- o. Provide spare parts specified hereinafter.

SITE QUALITY CONTROL

4.01 QUALITY ASSURANCE PROGRAM

- A. Implement a pro-active Quality Assurance Program. This program shall consist of the following minimum requirements.
 - 1. Assign a single individual to be responsible for the management of the Quality Assurance Program.
 - 2. The Quality Assurance Manager shall maintain documentation of:
 - a. Resumes for all employees, both office and field, working at any time on the project.
 - b. Training for employees, both office and field, and subcontractors, on the Quality Assurance Program.
 - c. Written verification that each worker on the project, including subcontractors, has read the specification sections outlining the project requirements for their area of specialty. No work shall be performed by any individual or company until this requirement has been met. The initial project team shall be documented in the first project submittal.
 - d. A detailed audit trail (QA Audit Report) for all Quality Assurance issues including: problem ID number, date of original problem report, name of individual initiating report, the individual assigned responsibility for resolving the problem, all correspondence related to the problem, and final problem resolution.
 - 3. Each employee and subcontractor shall be responsible for identifying and reporting Quality Assurance problems and for assisting, as requested by the Quality Assurance Manager, in the resolution thereof.
 - 4. All Quality Assurance related correspondence shall include the problem ID number.

4.02 MANUFACTURER SERVICES

4.03 SYSTEM STARTUP

- A. General Requirements.
 - 1. Work under this section shall comply with all controls-related commissioning requirements as presented in Division 01 Commissioning.

2. Testing required under This Section and in the commissioning specification 'post start-up testing' section shall be successfully completed and documented prior to the start of the functional performance procedures, also described in the commissioning specification.

B. Field Points Testing

1. Verify that all of the installed points receive or transmit the correct information, prior to loading/activating the system software.
2. Individually document the testing of each control point, with the date, persons involved and their signatures.
3. Failure to provide documented testing will be considered incomplete control point testing.
4. Binary Input Point Testing: manually turn each load on/off at the motor starter or VFD or by manual jumper across the field device contacts and verify proper software status
5. Binary Output Point Testing: manually enter an ON/OFF command and verify proper equipment operation
6. Binary Mismatch Alarm Testing: while commanded on, manually turn off the load at the motor starter or VFD to generate / verify a status mismatch alarm is generated
7. Disambiguation Testing: where a controller receives two or more input points of a common type (e.g. temperature, humidity, pressure, safety switches, fire alarm contacts), disable each device one at a time (by installing jumpers, lifting wires, or similar means) and verify that a failure of the correct device is generated. For analog sensors, this test shall precede field verification of sensor calibration to ensure that the correct sensor is being checked for calibration.
8. Analog Input Point Testing: compare the software reading to the value obtained from an independent test instrument at each field sensor. Test instrument shall provide a greater accuracy than the field sensor being tested, be a product manufactured for the sole purpose of field accuracy testing and shall bear a certificate of calibration. Total error shall not exceed the specified field sensor error plus the test instrument's rated maximum error.
9. Calibration: calibrate sensors as required to achieve the specified accuracy. This calibration shall be performed for all analog input field sensor except as follows;
 - a. Terminal unit space temperature sensors located on interior walls. (All space temperature sensors on perimeter walls, perimeter columns and interior columns that are partially outdoors at a lower elevation shall be tested.)
 - b. Terminal unit discharge air temperature sensors.
 - c. Sensors that are factory calibrated using NIST traceable procedures and equipment, and not subsequently damaged or exposed to weather and dust before or after field installation.
10. Work jointly with the TAB contractor and the CxA to field verify calibration of all air and water flow stations and differential pressure sensors. Calibration shall be done at a minimum of 2 different operating conditions: (1) at maximum (design) flow and (2) at minimum (or partial) flow.
11. Analog Output Point Testing: test with the systems operating under normal pressures using an override command to position each output device from minimum (2 VDC) to maximum (10 VDC) output signals in 50% output steps (2, 6, 10 VDC) and verify visually the output position at each step.
12. Provide documentation of Field Points Testing per the 'Contractor Post Start-Up Test Reports' section of the commissioning specifications.

C. Software Installation

1. Prior to functional performance testing, load controller software, startup the system, perform all necessary testing, and run diagnostic tests to ensure proper operation of the system. Generate all software and enter all database information necessary to perform the sequences of operation required.

D. Trend Logs

1. Prior to functional performance testing, create trend logs of input and output points. At minimum create the specified trend logs to record at intervals and for durations specified. Specific additional points to trend, shorter trend intervals, and longer durations to support Commissioning activities shall be jointly determined by the contractor, CxA, and Engineer. Submit logs to both the CxA and the Engineer for review prior to performing the commissioning functional procedures.

E. P.I.D. Loop Tuning

1. P.I.D. Loop tuning shall be documented for all major control loops as jointly determined by the Engineer and CxA by providing a trend log of 96 entries at one minute intervals for control input, set point and control output. Loop output cycling under a steady load condition shall be less than $\pm 5\%$ on average. Provide positive and negative "Bump" tests demonstrating loop stability by raising/lowering loop set point for fifteen minutes.

F. Workstation Graphic Displays

1. Operator Workstation color graphic displays shall be sufficiently complete (including proper display and function of all control points, system graphics, trending capabilities, and related text screens) and operational prior to claiming readiness for Functional Performance Procedures as required in Division 1, Section 01 91 10 and Section 23 08 01. Additionally, these capabilities shall be substantially complete at least two weeks prior to beginning the Fire Life Safety Procedures Division 1, Section 01 91 10, and Section 26 08 00 and the Emergency System Procedures Division 1, Section 01 91 10, and Section 26 08 00. Should the BAS Contractor fail to deliver these displays, then the BAS Contractor shall owe the Owner a day of on-site technical support for each day of delay.

G. Functional Performance Tests

1. Perform functional performance tests in the presence of the CxA. Each test shall include the following tasks, or as defined otherwise by the CxA:
 - a. Measure the time expended to display fully the latest real-time point data on several color graphic displays at the operator workstation. The BAS performance shall display each completed graphic with the latest real-time point values within fifteen seconds of command. It shall be possible to toggle between multiple graphics within 10 seconds each.
 - b. One input control point on any digital controller on any tier network shall be manually altered to create an alarm condition.
 - c. Critical alarms shall report to the operator workstation within 5 seconds. Priority alarms shall report to the operator workstation within 10 seconds. Non-critical alarms shall report to the operator workstation within 15 seconds.
 - d. Demonstrate stable control ($\pm 0.5^\circ\text{F}$) of the discharge air or water temperature within 5 minutes of a set point change.
 - e. Demonstrate stable control ($\pm 3\%$ RH) of the discharge air humidity within 5 minutes of a set point change.
 - f. Demonstrate stable control (± 0.2 inches w.c.) of the duct air pressure within 5 minutes of a set point change.
 - g. Demonstrate stable control (± 0.5 PSID) of the differential water pressure within 5 minutes of a set point change.
 - h. Provide trend reports for all points tested above. Each point shall be log once per minute for one hour during control stability tests.
 - 1) The BAS Contractor shall implement performance verification testing for the following systems:

- (a) Primary, secondary, and tertiary chilled water systems and open system port gateway communication to individual pump VFDs.
 - (b) Steam system.
 - (c) Mechanical room ventilation system.
 - (d) Transformer, switchboard, and switchgear room ventilation systems.
 - (e) Miscellaneous exhaust fans.
 - (f) Miscellaneous terminal units, including fan coils.
 - (g) Stand-by power system monitoring.
 - (h) Fire alarm system monitoring.
 - (i) All thermostatically controlled exhaust fans, unit and cabinet heaters.
 - (j) Each data connection interface for:
 - (k) Chilled water pump VFSs.
 - (l) Air handling unit and exhaust fan VFDs.
 - (m) Gas detection equipment factory authorized representative shall conduct performance verification testing of each and every gas monitoring and detection equipment. Performance verification testing to be coordinated by the BAS contractor to coincide with inspection and CxA efforts. Factory authorized start-up representative shall provide BAS contractor with written certification that the gas monitoring and detection equipment is calibrated and operational. Written certification to be included with the BAS contactors close out documentation.
 - (n) All systems included in the base bid Scope of Work and as listed herein section 230900 - 3.1 – A – 2.
- i. Repeat Functional Performance Testing for each system until Functional Performance Testing requirements are met.
- H. Non-Compliant Work.
 - 1. Remove and replace, at no cost to the Owner, all items which are not in compliance with the specification requirements.
 - 2. Correct any actuator/shaft slippage by positively affixing (drilled and set screwed) actuators, as required by CxA and/or Engineer.
- I. Punch List Review
 - 1. The Engineer shall perform an initial punch list review following completion of all specified Commissioning activities. Provide on-site technical assistance at no additional cost when requested by the CxA or Engineer to demonstrate compliance to these specifications.

4.04 ADJUSTING

- A. Following installation and system startup, regulate and adjust all thermostats, control valves, motors, and any other controls related equipment.

4.05 SECURITY

- A. General:
 - 1. Security of the systems and equipment provided under this Section is of critical importance. Secure systems and equipment in “best practice” manner against internal and external threats, intentional and accidental actions, and malicious and non-malicious intentions, to the maximum degree possible. Beginning from the time of bid preparation through system acceptance and warranty period, if security vulnerabilities are identified, and appropriate counter-measures are not possible within the contract scope of work (as

- expressed in drawings and specifications), identify these vulnerabilities to the Engineer and Owner immediately.
2. The systems and equipment provided under this Section are intended to achieve Information Assurance consisting of availability, integrity, authentication, confidentiality, and non-repudiation. Installers and providers of systems and equipment under this Section shall consider security measures that address people, technology, and operations. Provide adequate training and coordination with Owner to address Owner's critical and ongoing role in maintaining Information Assurance, through appropriate policies and procedures, during and after warranty period.
 3. All parties understand that all products and networks have inherent weaknesses, and that a determined and skilled adversary will manage to defeat any security measure deployed. The requirements of this Article do not intend to hold the installers and providers of systems and equipment under this Section responsible for losses or damages resulting from a breach. The requirements of this Article do intend to hold the installers and providers responsible for deploying layered defense (this is referring to a particular method of security, something we do not want to do.) Also it's holding the installers and providers responsible but sec 2 says that it's not their responsibility. "security monitoring and counter measure" or prudent security controls should be a better phrasing measures against common and known vulnerabilities, in order to deter and protect against exploits targeting those vulnerabilities by all but the most determined and skilled adversary.
 4. The requirements of this Article intend to set minimum acceptable details of security execution, but these requirements are not inclusive of all security measures available (as soon as the equipment is installed a level of risk acceptance is the sole responsibility of the client we encourage securing the system(s) to be done simultaneously as the install is being performed to keep the level of accepted risk to a minimum accepted time) this is mentioned in the next two bullet points but if it could be rephased in some way to not make this bullet stand out., nor are they inclusive of future threats and counter-measures unknown at the time this Article was prepared. Secure systems and equipment in manners which exceed, enhance, or deviate from these minimum requirements when required; to counter known threats, to counter known vulnerabilities, when recommended by manufacturer literature, and when recommended by industry best practice.
 5. It is the responsibility of the installer of each system and equipment, to secure their portion of the Work, and to coordinate security at the perimeter of their portion of the Work with the security of connections to Work provided by other system and equipment installers.
 6. Extensively coordinate the security solution with Owner. Successful security relies on proper implementation by installer, coupled with ongoing attention to policies, procedures, and upkeep by Owner. Additionally, Owner may be providing some aspects of the complete security solution, for example firewalled external access, or Active Directory interface for user credentialing.
- B. Layered Defense in Depth: (again this is one type of a security topography making a suggestion for this type of security topography would lead us open if something were to happen.) we can have this as an example of a secure practice but depending on industry standards or other security mechanisms "Security Controls" or "Security Measures".
1. Plan and implement a multi-layered defense in depth security solution for all aspects of systems and equipment provided under this Section.
 2. Provide physical security of system devices and network drops by using key-locked panels or by locating panels in access-controlled locations.
 3. Provide physical security of network cabling by conforming to conduit requirements of this Section and related sections.
 4. Provide software security:

- a. Implement a 'role-based access control' permissions model. Discuss users, roles, and permissions with Owner, and implement initial configuration according to Owner needs. Create one account per user. Create minimum of six roles. Assign roles to users, and assign permissions to roles, according to Owner needs. Configure default permission to all system elements as prohibited to view / read / write, with specific permissions to view / read / write each system element granted by exception according to role authorization.
 - b. Coordinate users and roles with Owner's network administrator, if applicable and acceptable to Owner. Implement Owner's Active Directory for account management if possible and acceptable to Owner. For each other Enterprise Application with interface to the system (such as maintenance management, fault diagnostics, etc), create a unique user account for machine to machine connection.
 - c. Enforce strong passwords and require periodic password changes.
 - d. Implement automatic log off after inactivity time-out.
 - e. Implement other security features available in each software system according to manufacturer recommendations to achieve maximum security posture.
5. Provide anti-virus software for all personal computer and server computer platforms provided under this Section. Retain an active subscription to virus definition updates from the time of system acceptance to the end of system warranty period. Utilize Owner-provided and –managed anti-virus software in lieu of this requirement when requested by Owner.
6. Provide 'role-based access control' permissions model for the files and software applications stored on the system file structure. Users without sufficient permission shall not view, copy, or modify the files and software applications.
7. Remove all guest account access, or similar accounts which do not require unique user login. Change all default usernames. Change all default passwords. Provide Owner with an administrator-level user account with Owner-controlled password for all systems including operating systems, which will permit Owner to delete or modify any user accounts created by the installer, manufacturer, or provider.
8. Harden all systems and equipment provided by reducing the surface of vulnerability with measure such as:
 - a. Remove unnecessary software.
 - b. Disable or remove unnecessary services.
 - c. Disable unnecessary file and resource sharing.
 - d. Remove unnecessary accounts.
 - e. Configure options in software applications such as web browsers, document readers, and productivity suites, for enhanced security posture.
 - f. Apply software firewalls and spyware protection where available.
 - g. Enable screen lock and automatic software log out after inactivity time.
9. Provide network security. Coordinate network security solutions with Owner. Unless agreed otherwise, provision VLAN to support all elements of the system.
10. If external inbound access to system is desired by Owner, Owner will provide connection and secure all inbound traffic. Identify port/protocol requirements and coordinate system configuration needs with Owner team.
11. If external outbound access is permitted by Owner, for services such as weather updates or time synchronization, Owner will provide connection and secure all outbound traffic. Identify port/protocol requirements, identify all external URLs or IP addresses necessary, and coordinate system configuration needs with Owner.
12. If alarm distribution or system supervision is desired by Owner, Owner will provide SMTP host which will be capable of relaying emails originating from the system, and/or Owner will provide SNMP network manager capable of receiving traps. Coordinate system

configuration needs with Owner. Coordinate alarm distribution email address aliases when appropriate.

13. Provide periodic back-up of all system data files, including historical trend data, run-time system configuration files, controller application files, and similar unique / custom files. Storage space for back-up will be provided by Owner – push periodic back-ups to Owner storage.
14. Provide user activity log which logs all user actions. Only administrator-level user shall have permission to modify the user activity log. Size log buffer and tune archive interval as necessary, in order to capture all user actions to permanent database storage without any loss of data during periods of rapid activity by multiple simultaneous users.

C. Refer to additional specific security requirements of related sections of these specifications.

4.06 CLOSEOUT ACTIVITIES

A. Training

1. General Requirements
 - a. Training shall comply with Section 01 91 00 - General Commissioning Requirements.
 - b. Comply with Division 1 and Section 01 91 00 training requirements as well as this section.
 - c. On-Site Operator Instruction - three 4 hour sessions (12 hours total).
 - d. Supplemental On-Site Operator Training – one 4 hour session.
2. Training Qualifications
 - a. Training instructor shall be under the direct employment of the control system manufacturer as a designated instructor.
 - b. The instructor may, upon approval by Owner's Representative, be an employee of the MCMS Contractor.
 - c. The instructor must have a minimum of five years of experience with the control system products as installed in the facility and shall be specifically trained and certified by the control system manufacturer to conduct system training.
3. Training Materials
 - a. Provide a course outline for each training course.
 - b. Provide training materials and workbooks.
4. On-Site Operator Instruction
 - a. Prior to the initial system startup, provide training sessions for the building operating personnel as specified in this Execution section. Training shall cover basics of system operation and sequences of operations.
5. Supplemental Operator Training
 - a. Additional instruction shall be given at a time as coordinated between the contractor and the owner within the duration of the warranty period and the bounds of the training hours requirements, as specified in this Execution section.

4.07 PROTECTION

- A. Properly protect work and work of other trades from damage.
- B. Wherever possible, coordinate equipment deliveries with the manufacturers and/or suppliers such that equipment is delivered to the site when it is required, or so that it may be suitably stored within the building and protected.

4.08 MAINTENANCE

- A. Operation During Construction:
 - 1. Maintain all systems and equipment operated during construction. The contractor responsible for the installation of the system shall operate and maintain it. Make all repairs and perform all maintenance to assure Work is turned-over to Owner in first class condition.
- B. Programming Revisions
 - 1. Provide 120 hours of additional programming time to be used during the project schedule at the request of the Owner or Owner's Consultants. Programming tasks shall be pre-approved by the Owner's Project Manager. Document hourly time for each task on a work order form and submit within one month to the Owner's Project Manager. Only authorized and documented hours will apply toward meeting the total hourly requirement.
- C. The BAS contractor shall prepare at bid time the pricing for the following maintenance agreement.
 - 1. First Year In-Warranty Technical and Software Support Agreement. Provide the following during normal business hours:
 - a. Semi-annual on-site operator coaching/training. One (1) two hour session for each shift.
 - b. Semi-annual on site software database back-ups for all controllers and OWS.
 - c. On or off-site software database reload, as many times as required.
 - d. Off-site online telephone support. Unlimited.
- D. Annual Service Agreement Escalation Rate. Provide an annual escalation rate (%) for cost increases in the Out of Warranty Support Agreement specified above, valid for agreement years 2 through 5.

SECTION 230913

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ANSI 125 - x.
- B. ANSI/FCI 70-2 - Control Valve Seat Leakage.
- C. NEMA 3R - Electrical Enclosures.
- D. NEMA 4 - x.
- E. UL 508 - Industrial Control Equipment.
- F. UL 2075 - Standard for Gas and Vapor Detectors and Sensors.

1.02 SUMMARY

- A. Section Includes:
- B. Products Furnished but Not Installed under This Section:
 - 1. Piping Specialties: thermo-wells, flow sensor taps
 - 2. Control Valves
- C. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including the General Conditions and Supplementary Conditions apply to this section.
 - 2. Division 01 Specification Section
 - 3. HVAC Control Sections:
 - a. Section 23 09 00 – Common Work Results for HVAC Control
 - 1) Requirements common to all HVAC Control Sections
 - b. Section 23 09 23 – Direct-Digital Control System for HVAC
 - 1) DDC networks, DDC controllers, DDC software
 - c. Section 23 09 63 – Integrated Automation
 - 1) BAS computer hardware, BAS software

1.03 SUBMITTALS

- A. Refer to 23 09 00 Submittals for requirements applicable to This Section, in addition to the requirements of This Article
- B. Product Data:
 - 1. Schedules:
 - a. Control Damper Schedule: One row for each damper, one column for each of the following attributes in the order presented here, no omissions:
 - 1) Line Number
 - 2) Damper Tag

- 3) System
 - 4) Service
 - 5) Damper Size (outside dimensions) (width x height, inches)
 - (a) Section Labels & Sizes (width x height, inches)
 - 6) Size of Damper Opening (inside dimensions) (width x height, inches)
 - 7) Resultant Free Area of Damper (square feet)
 - 8) Design Airflow Rate (CFM)
 - 9) Design Velocity (FPM) (Design Velocity = Design CFM / Resultant Free Area)
 - 10) Design Pressure Drop with Damper Full Open (in. w.c.)
 - 11) Damper Manufacturer
 - 12) Damper Part Number
 - 13) Blade Pattern (parallel, opposed, round)
 - 14) Blade Type (air foil, insulated, thermally broken, etc.)
 - 15) Blade Material
 - 16) Frame Material
 - 17) Fail Position (when de-energized):
 - (a) (NO) normally open
 - (b) (NC) normally closed
 - (c) (FLP) fail in last position
 - 18) Actuator Model Number
 - 19) Actuator Quantity
 - 20) Actuator Signal Range (in volts, mA or psi as applicable)
 - 21) Actuator Mounting Location (electronic; shaft, sleeve-out collar, channel support)
 - 22) Comments
- b. Control Valve Schedule (Pressure Dependent): One row for each valve, one column for each of the following attributes in the order presented here, no omissions:
- 1) Line Number
 - 2) Valve Tag
 - 3) System
 - 4) Service
 - 5) Pipe Size
 - 6) Body Pattern (e.g. straight thru, mixing, diverting)
 - 7) Load (Coil) Flow Rate (actual from submittals)
 - 8) Load (Coil) Pressure Drop (actual from submittals)
 - 9) Calculated Valve Cv
 - 10) Selected Valve Cv
 - 11) Actual Valve Pressure Drop
 - 12) Manufacturer

PART NUMBER

2.01 BODY STYLE (E.G. GLOBE, BUTTERFLY, BALL)

- 1) Valve Size
- 2) Pipe Connections (sweat, screwed, flanged)
- 3) Fail Position (when de-energized): (e.g. open, closed, last position, thru coil, bypass coil)
- 4) Actuator Model Number
- 5) Actuator Signal Range (in volts, mA or PSI as applicable)

- 6) Actuator Close-Off Pressure (against system)
- 7) Comments
- b. Control Valve Schedule (Pressure Independent): One row for each valve, one column for each of the following attributes in the order presented here, no omissions:
 - 1) Line Number
 - 2) Valve Tag
 - 3) System
 - 4) Service
 - 5) Pipe Size
 - 6) Body Pattern (e.g. straight thru, mixing, diverting)
 - 7) Load (Coil) Flow Rate (actual from submittals),
 - 8) Manufacturer

PART NUMBER

3.01 VALVE SIZE

- 1) Pipe Connections (sweat, screwed, flanged)
 - 2) Fail Position (when de-energized): (e.g. open, closed, last position, thru coil, bypass coil)
 - 3) Actuator Model Number
 - 4) Actuator Signal Range (in volts, mA, or PSI as applicable)
 - 5) Comments
 - b. Air Flow Measuring Station Schedule: One row for each flow station, one column for each of the following attributes in the order presented here, no omissions:
 - 1) Line Number
 - 2) Station Tag
 - 3) System
 - 4) Service
 - 5) Opening Size (w x h)
 - 6) Design Flow Rate
 - 7) Design Velocity
 - 8) (VP-type only) Design Velocity Pressure
 - 9) Selected Station Size (w x h)
 - 10) Selected Velocity
 - 11) (VP-type only) Selected Velocity Pressure
 - 12) (Thermal Dispersion only) Selected Sensor Quantity / Arrangement (w x h)
 - 13) Section Labels & Sizes (w x h)
 - 14) Station Manufacturer
 - 15) Station Part Number
 - 16) Output Signal Type (e.g. volts, mA, network)
 - 17) (VP-type only) Velocity Pressure Sensor Range
 - 18) (VP-type only) Velocity Pressure Sensor Manufacturer
 - 19) (VP-type only) Velocity Pressure Sensor Part Number
 - 20) Comments
- B. Shop Drawings:
1. Damper Elevations:
 - a. For each damper of three or more sections wide or high
 - b. Show the position of each section and associated actuator mounting arrangement

PART 2 PRODUCTS

4.01 GENERAL

A. Accuracy Requirements:

1. Specified accuracy requirements below are inclusive of hysteresis, non-repeatability, and non-linearity factors according to IEC 61298-2 unless noted otherwise.
2. Specified accuracy requirements below are inclusive of device electronics such as transmitters, A/D conversion, and D/A conversion,
3. Factory calibration of devices shall be included when required to meet specified accuracy or attain manufacturer's stated device accuracy percentage.
4. In addition to overall device accuracy percentage, device data shall indicate: hysteresis, non-repeatability, non-linearity, method of non-linearity used, and method of accuracy calculation used to express overall device accuracy.

4.02 INPUT DEVICES

A. Temperature Sensors:

1. General Requirements:

- a. Provide sensors and transmitters required as outlined in the sequence of operation and Control Point Matrix as required to achieve the specified accuracy as specified herein.
- b. Temperature transmitters shall be equipped with individual zero and span adjustments. Provide a loop test signal to aid in sensor calibration.
- c. Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearity's of the sensor and bridge and provide a true linear output signal.
- d. Temperature sensor shall be of the resistance type and shall be either three-wire 100-ohm platinum RTD, or two-wire 1000-ohm platinum RTD.
- e. Thermistors are acceptable provided the mathematical relationship of a thermistor with respect to resistance and temperature with the thermistor fitting constraints is contained with the digital controller operating software and the listed accuracies can be obtained. Submit proof of the software mathematical equation and thermistor manufacturer fitting constants used in the thermistor mathematical/expressions. Thermistors shall be of the Thermistor (NTC) type with a minimum of a 50 ohm/°F (28 ohm/°C) resistance change versus temperature to insure good resolution and accuracy. Thermistors shall be certified to be stable 0.24°F (0.13°C) over 5 years and 0.36°F (0.20°C) accurate and free from drift for 5 years.
- f. The following accuracies are required and include errors associated with the sensor, lead wire and A to D conversion:
 - 1) Accuracy
 - 2) $\pm 0.5^{\circ}\text{F}$ (0.28°C)
 - 3) $\pm 0.5^{\circ}\text{F}$ (0.28°C)
 - 4) $\pm 0.5^{\circ}\text{F}$ (0.28°C)
 - 5) $\pm 0.5^{\circ}\text{F}$ (0.28°C)
 - 6) $\pm 0.25^{\circ}\text{F}$ (0.14°C)
 - 7) $\pm 0.75^{\circ}\text{F}$ (0.42°C)

2. Immersion Temperature Sensors:

- a. Immersion temperature sensor, transmitter, and thermo-well shall be supplied as a complete assembly including well head and conduit connection.

- b. Temperature sensor shall comply to the general requirements stated above.
- c. Thermo-wells shall be pressure rated and constructed in accordance with the system working pressure.
- d. Thermo-wells and sensors shall be mounted in a $\frac{3}{4}$ " (21mm) NPT thread-o-let and allow easy access to the sensor for repair or replacement. Thermo-wells shall be rotated 45° below the horizontal plane to reduce condensation build-up.
- e. Thermo-wells shall be constructed of the following materials:
 - 1) Chilled and Hot Water; brass.
 - 2) Condenser Water and Steam; 316 stainless steel.
 - 3) Install thermally conductive paste in thermo-well before installation of immersion sensor.
- 3. Room Temperature Sensors:
 - a. Room sensors shall be constructed for surface mounting. Room sensors constructed for flush mounting (flat plate type) sensors are not allowed, unless specifically noted otherwise. No visual indication of room temperature shall be provided, except in the patient rooms.
 - b. Room sensors shall have the following options;
 - 1) Set point adjustment providing a $\pm 3^{\circ}\text{F}$ ($\pm 2^{\circ}\text{C}$) (adj.) range.
 - 2) Momentary override request push button for activation of after hour operation.
 - 3) Room sensors installed in high traffic public areas (corridors, lobbies, waiting rooms, vestibules) shall have blank covers with no set point adjustment or override pushbutton.
 - 4) All room temperature sensors located on perimeter walls or columns shall be installed with a thermally insulated electrical wall box, free of air infiltration from the wall or column cavity.
- 4. Outside Air Sensors:
 - a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
- 5. Duct Mount Sensors:
 - a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement, with a grommet or gasket at the hole to prevent air leaks.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Duct sensor probes shall be constructed of 304 stainless steel.
 - c. For outdoor air duct applications, use a weatherproof mounting box with weatherproof cover and gasket.
- 6. Averaging Sensors:
 - a. For ductwork greater than 48" (1.31 yard) in any dimension and/or where air temperature stratification exists, provide an averaging type sensor with multiple sensing elements.
 - b. The averaging string shall have a minimum of 4 sensing elements per 8' (2.73 yard) and 12' (3.83 yard) long segment and 9 sensing elements per 25' (8.75 yard) long segment.
 - c. For larger duct and plenum applications, provide several sensors mounted across the plenum to account for stratification and/or air turbulence. Provide one foot of sensor length per one square foot of duct area.
 - d. Provide capillary supports at the sides of the duct to support the sensing string.

7. Acceptable Manufacturers:
 - a. Thermistors: PreCon Type-2 or 3, ACI.
 - b. Platinum RTD: PreCon, ACI, Johnson Controls, Siemens
- B. Humidity Sensors:
 1. General:
 - a. Humidity sensor elements shall resist service contaminations.
 - b. Humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
 - c. The humidity transmitter shall provide an overall accuracy specified below including lead loss and analog to digital conversion.
 - d. Humidity sensor output shall be temperature compensated.
 - e. Transmitters shall be shipped factory pre-calibrated.
 2. Outdoor and Fan System Duct Relative Humidity Sensors:
 - a. Outdoor and fan system duct humidity sensors shall be of the capacitive or bulk polymer resistive design with a minimum $\pm 2\%$ accuracy over 20-95% RH.
 - b. Outdoor sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 4 enclosure with seal tight fittings and stainless-steel bushings.
 - c. Duct sensing probes shall be constructed of 304 stainless steel and be equipped with a flexible grommet / gasket, bushings, and a mounting bracket.
 - d. Outdoor air and fan system duct humidity sensors shall be Vaisala HMD60 series with optional DTR503B weather shield or Kele Hx20K series, no exceptions.
 - e. Provide to match sensor manufacturer, HMI41 or Easycal one-point humidity calibrator, for field calibration.
- C. Differential Pressure Sensors:
 1. General Air and Water Pressure Sensor Requirements:
 - a. Pressure sensors shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing contractor and Owner permanent easy-to-use connection.
 - d. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.
 - e. Provide a two-year warranty for each transmitter. Replace all transmitters found to be defective at no cost to the Owner during the warranty period.
 2. Water Differential Pressure Applications:
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments adjustable from the outside cover and meet the following performance specifications:
 - 1) Maximum differential pressure range 1 to 100 psid (1kPa to 102 psi). Select range appropriate for system application.

- 2) Reference Accuracy: $\pm 0.5\%$ of full span (includes non-linearity, hysteresis, and repeatability).
 - 3) Transmitter shall be temperature compensated.
 - c. Mount stand-alone pressure transmitters in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with hi and low connections piped and valved. Air bleed units, bypass valves and compression fittings shall be provided.
 - d. Acceptable Manufacturers:
 - 1) Setra
 - 2) Rosemount.
3. Pump Differential Pressure Applications:
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure sensing points.
 - b. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage. Pressure transmitters shall be constructed to withstand 500% pressure over-range without bursting.
 - c. The differential pressure transmitter shall have dip-switch selectable operating range adjustments, adjustable from inside the cover. The differential pressure transmitter shall have push-button zero adjustment, resettable from inside the cover.
 - d. The differential pressure transmitter shall meet the following performance specifications:
 - 1) Maximum differential pressure range 1 to 250 psid (1 psi to 247 psi). Select range appropriate for system application.
 - 2) Reference Accuracy: $\pm 1.0\%$ of full span (includes non-linearity, hysteresis, and repeatability).
 - 3) Transmitter shall be temperature compensated.
 - e. The differential pressure transmitter shall be remotely mounted at the process. The differential pressure transmitter and electronics shall be enclosed in a NEMA 4 enclosure.
 - f. The differential pressure transmitter shall have a LCD display for local indication of; high port pressure, low port pressure, and differential pressure.
 - g. The transmitter shall be installed with high and low connections piped and valved. Air bleed units, bypass valves and compression fittings shall be provided.
 - h. The differential pressure transmitter shall have a 5 year warranty.
 - i. Acceptable Manufacturers:
 - 1) Veris Industries PW2 Series.
4. Building Differential Air Pressure Applications (± 0.25 " WC (± 60 Pa)):
 - a. The differential pressure transmitter shall use thermal dispersion technology and transmit a linear 0-10 VDC output in response to variation of differential pressure.
 - b. Acceptable Manufacturers: Ebtron, Tek Air.
 - c. Provide shielded static pressure probe at each end of building differential pressure sensors. Probe shall have multiple sensing ports, impulse suppression chamber and airflow shielding. Provide suitable probe for indoor & outdoor locations.
5. Duct Differential Air Pressure Applications (0" to 5" WC (0 to 1200 Pa)):
 - a. The differential pressure transmitter shall transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments adjustable from the outside cover and meet the following performance specifications:

- 1) (0" WC - 1" WC through 0" WC - 5" WC (0 Pa - 250 Pa through 0 Pa - 1200 Pa)) input differential pressure ranges. Select range appropriate for system application.
 - 2) 4-20 mA output.
 - 3) Maintain accuracy up to 20 to 1 ratio turndown.
 - 4) Reference Accuracy: +0.5% of full span.
 - c. Acceptable Manufacturers:
 - 1) Modus
 - 2) Setra
- D. Air Flow Measuring Stations:
 1. Duct Air Flow Measuring Stations:
 - a. Integral Transe Traq dampers with Outside Air monitoring are to be provided with the Air Handling Unit.
 - b. Supply Fan array to be supplied with integral piezo cones and flow transmitters for each fan.
- E. Status and Safety Switches:
 1. General Requirements:
 - a. Switches shall be provided to monitor equipment status, safety conditions and generate alarms at the BAS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and interlock wired to shut-down respective equipment.
 2. Current Sensing Switches:
 - a. Current sensing switch shall be self-powered with solid state circuitry and a dry contact output. It shall consist of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over current up to twice its trip point range.
 - b. Current sensing switches shall be used for run-status for fans, pumps, and other miscellaneous motor loads.
 - c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - d. Acceptable Manufacturers:
 - 1) Hawkeye
 - 2) Johnson Controls
 - 3) Siemens.
 3. Air Pressure Safety Switches:
 - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120 VAC (220 VAC).
 - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
 - c. Acceptable Manufacturers:
 - 1) Cleveland Controls
 - 2) Johnson Controls
 - 3) Siemens

4.03 OUTPUT DEVICES

A. Control Relays

1. Control Pilot Relays:
 - a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
 - b. Mounting bases shall be snap-mount.
 - c. Provide DPDT, 3PDT or 4PDT relays as appropriate for application. Relays shall have one spare SPDT set of contacts.
 - d. Contacts shall be rated for 10 amps at 120VAC (220 VAC).
 - e. Wire Size: 2-#12 AWG per terminal.
 - f. Terminal: M3.5 screws with captive wire clamp.
 - g. Relays shall have an integral indicator light and check button.
2. Fan Safety Alarm Circuit Relays:
 - a. Packaged product containing multiple relays, intended to supervise multiple safety sensor digital inputs, allow discrete supervision of each digital input, and actuate a single pilot-duty relay for fan or actuator shut-down, with alarm indicator lights and bypass dip-switches.
 - b. Form Factor: exposed track mount when installed internal to control panel or enclosed in NEMA-1 enclosure with clear plastic lid and threaded conduit nipple when installed external to control panel.
 - c. Power Input: 4 amps maximum, 24VAC
 - d. Expected Relay Life (each relay): 10 million cycles mechanical
 - e. Operating Conditions: -30 to 140°F (34°C to 60°C), 5 to 95%RH (noncondensing)
 - f. Alarm Inputs: four or six inputs as needed to accept all related safety inputs in one module, each input accepts normally-closed sensor that opens on alarm, each input wetted by 39mA 24VAC maximum, each input actuates dedicated internal DPDT relay for isolation
 - g. Alarm Indicator Lights: red LED, one per input, driven by dedicated contacts of alarm input relay, lights on alarm
 - h. Discrete Supervisory Contacts: one per input, driven by dedicated contacts of alarm input relay, opens on alarm
 - i. Master Relay: Dedicated DPDT internal relay for isolation, two sets of 24VAC outputs provide 24V when normal and remove voltage upon any alarm driven by dedicated contacts of master relay, one pilot-duty dedicated contact of master relay rated for maximum 10 amps at 277VAC.
 - j. Approvals: UL Listed, UL916, UL864, CE, RoHS
 - k. Basis of Design Product: Functional Devices RIB(MN)LB-X

B. CONTROL DAMPERS

1. Size and select control dampers and actuators for each specific application and installation location, and as specified in the sequence of operation and on drawings
 - a. Opposed Blade Type: Unless noted otherwise, used for throttling air flow, sized so that when wide open the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear, provided with modulating actuator
 - b. Parallel Blade Type: Unless noted otherwise, used for two-position isolation only, provided with two-position actuator unless
2. Control Damper Requirements:
 - a. Indoor Dampers (Dampers NOT exposed to outdoor / ambient conditions):
 - 1) Product: TAMCO Series 1500, no substitutions
 - 2) Damper Frame: Extruded aluminum (6063T5) not be less than .080" (thickness, 4" (minimum deep
 - 3) Damper Frame: Extruded aluminum (6063T5) not be less than . (0.08 inch) thickness, (3.94 inch) minimum deep

- 4) Damper Blades: Extruded aluminum (6063T5) airfoil profile, with end caps to seal hollow interior and to reduce air leakage
 - 5) Blade Gaskets and Frame Seals: Extruded silicone, secured in an integral slot within the aluminum extrusions
 - 6) Bearings: Celcon inner bearing fixed to an 7/16" (0.43 inch) aluminum hexagon blade pin rotating within a polycarbonate outer bearing inserted in the frame
 - 7) Linkage Hardware: Aluminum, zinc plated steel, nickel plated steel, installed in the frame side, complete with cup-point trunnion screws for a slip-proof grip
 - 8) Operating Temperature Range: -40°F to 212°F (-40°C to 100°C)
 - 9) Air Leakage: AMCA rated for Leakage Class 1A. A 60" x 48" (damper shall have less than 1.8 CFM/sqft (against 1.0" w.c. (differential pressure at standard air.
 - 10) Air Leakage: AMCA rated for Leakage Class 1A. A 1.64 yard x 1.31 yard) damper shall have less than (33 CMH/m²) against (250 Pa) differential pressure at standard air.
 - 11) Pressure Drop (at 1,000 fpm air velocity through fully open damper):
 - (a) For 12" x 12" Damper: Less than 0.05" (w.c.
 - (b) For 24" x 24" Damper: Less than 0.03" w.c.
 - (c) For 36" x 36" Damper (or larger): Less than 0.02" w.c.
 - 12) Pressure Drop: Less than 5 Pa) at 20013.12 yard/h) through a fully open 1.64 yard x 1.31 yard) damper
 - 13) Damper Manufacturer Warranty: Free of defects for a period of 2 years from the date of installation
- b. Outdoor Dampers (Dampers exposed to outdoor / ambient conditions):
- 1) Product: TAMCO Series 9000, no substitutions
 - 2) Damper Frame: Extruded aluminum (6063T5) not be less than .080" (0.08 inch) thickness, 4" (minimum 3.94 inch) deep. Entire frame shall be thermally broken by means of polyurethane resin pockets complete with thermal cuts.
 - 3) Damper Blades: Extruded aluminum (6063T5) airfoil profile, with end caps to seal hollow interior and to reduce air leakage. Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29.
 - 4) Blade Gaskets and Frame Seals: Extruded silicone, secured in an integral slot within the aluminum extrusions
 - 5) Bearings: Celcon inner bearing fixed to an 7/16" (0.43 inch) aluminum hexagon blade pin rotating within a polycarbonate outer bearing inserted in the frame
 - 6) Linkage Hardware: Aluminum, zinc plated steel, nickel plated steel, installed in the frame side, complete with cup-point trunnion screws for a slip-proof grip
 - 7) Operating Temperature Range: -40°F to 212°F (-40°C to 100°C)
 - 8) Air Leakage: AMCA rated for Leakage Class 1A. A 60" x 48" (damper shall have less than 1.8 CFM/sqft (against 1.0" w.c. (differential pressure at standard air.
 - 9) Air Leakage: AMCA rated for Leakage Class 1A. A 1.64 yard x 1.31 yard) damper shall have less than (33 CMH/m²) against (250 Pa) differential pressure at standard air.
 - 10) Pressure Drop (at 1,000 fpm air velocity through fully open damper):
 - (a) For 12" x 12" Damper: Less than 0.05" (w.c.
 - (b) For 24" x 24" Damper: Less than 0.03" w.c.
 - (c) For 36" x 36" Damper (or larger): Less than 0.02" w.c.
 - 11) Pressure Drop: Less than 5 Pa) at 20013.12 yard/h) through a fully open 1.64 yard x 1.31 yard) damper

- 12) Damper Manufacturer Warranty: Free of defects for a period of 2 years from the date of installation
3. Control Damper Configuration Requirements:
 - a. Multi-Section Dampers:
 - 1) Provide multiple dampers for a damper application when required based on damper manufacturer's specific recommendations for face velocity, differential pressure, and damper type, and according to the following maximums:
 - (a) Damper section with a face velocity of 1,500 FPM (or less shall not exceed 24 sq. ft ().
 - (b) Damper section with a face velocity between 1,500 FPM and 2,500 FPM (shall not exceed 18 sq. ft ().
 - (c) Damper section with a face velocity between 2,500 FPM (and 3000 FPM (shall not exceed 13 sq. ft ().
 - (d) Damper section with a face velocity of 29965 yard/h) or less shall not exceed 2.41 yard²).
 - (e) Damper section with a face velocity between 29965 yard/h and 49978.13 yard/h) shall not exceed 1.83 yard²).
 - (f) Damper section with a face velocity between 49978.13 yard/h) and 60039.37 yard/h) shall not exceed 1.31 yard²).
 - 2) Arrange multi-section dampers with electronic actuators so that each damper section operates individually, no exceptions. Mount one electronic actuator directly to the drive shaft of each section. Jack shafting, jumper linkages, or external linkages of any kind shall be prohibited.
 - 3) Dampers one or two sections wide: arrange to allow actuators to be direct shaft mounted on the outside of the duct
 - 4) Dampers three or more sections wide:
 - (a) Provide a 3-sided vertical channel (8" (7.87 inch W x 6" (5.91 inch D) ((200 mm W x (150 mm D) within the duct or fan housing and between adjacent vertical damper sections.
 - (b) Anchor vertical channel at the top and bottom to the fan housing or building structure for support
 - (c) Connect the sides of each damper frame to the channels
 - (d) Allow damper drive shafts to pass through holes in the channel for direct shaft mounting of actuators
 - (e) Orient open side of channel to face downstream side of the air flow
 - b. Dampers Flush with Wall: provide sheet metal collar 300 deep to bring damper section out of the wall to allow direct shaft mounting of the actuator on the side of the collar, or provide vertical channel support to house actuator mounted direct to shaft
4. Damper Actuators:
 - a. Type: electronic utilizing microprocessor controlled brushless DC motors
 - b. Mounting Arrangement: direct shaft mount only, no exceptions. Connecting rods and stand-off brackets shall be prohibited.
 - c. Acceptable Manufacturers:
 - 1) Belimo
 - 2) Honeywell
 - 3) Siemens.
 - d. Spring Return / Failure Position:
 - 1) Terminal unit dampers: fail-last-position unless noted otherwise
 - 2) All other dampers: provide with mechanical spring return feature unless noted as fail-last-position

- 3) Spring return shall permit normally open or normally closed position operation of same actuator by configuration or mounting arrangement
- e. Required Features:
 - 1) External adjustable stops, to limit the travel in either direction
 - 2) Gear release to allow manual positioning
 - 3) Removable crank to override the spring return and control signal, and manually position the damper
 - 4) Visual position indicator
 - 5) Integral current limiting circuitry or microprocessor overload protection
- f. Modulating Actuators:
 - 1) Power Supply: 24 VAC or VDC, maximum 15 VA power consumption
 - 2) UL listed
 - 3) Control Signal: 2-10 VDC or 4-20 mA. Floating signal shall be prohibited.
 - 4) Feedback Signal: Clamp position feedback signal of 2-10 VDC, independent of the input signal, may be used to parallel other actuators and provide true position indication
- g. Two-Position Actuators:
 - 1) Power Supply: 24 AC or 120 VAC (220 VAC)
 - 2) UL listed
 - 3) Feedback Signals: adjustable open and closed position switches integral to actuator
 - 4) Quick Acting: where required by sequence, shall move full stroke within 20 seconds
- h. Actuator Manufacturer Warranty: Free of defects for a period of 2 years from the date of installation

C. CONTROL VALVES

- 1. General Requirements:
 - a. Provide product of the same manufacturer for all valves and valve actuators of the same application and pressure rating.
 - b. Prior to installation on this project, each unique valve and actuator product family combination shall be factory tested together to operate under the temperature and pressure ratings and fluid type of the specific application. Furnish test documentation with product submittal. Previous factory testing or actual field experience of the same valve/actuator combination under the same or more demanding ratings shall be considered acceptable if adequate documentation is furnished.
 - c. One of each unique valve (over 3/4" (19mm)) and actuator combination shall be tested together at point of assembly for operation and shut-off leakage. Furnish test documentation for review and approval before valve shipment. The valve and actuator shall be shipped together as an assembled unit or re-assembled in the field by the same assembly personnel or the valve manufacturer's authorized distributor.
 - d. The valve manufacturer's authorized distributor shall extend to the field both the valve and actuator manufacturers' standard and extended factory product warranties. This shall include on-site labor to evaluate and correct deficiencies.
- 2. Technical Requirements:
 - a. Valve body static pressure rating shall be equal to or greater than the ANSI Class pressure rating of the pipe and suitable for the designated application
 - b. Coordinate pipe connection type (sweat, screwed or flanged) and porting arrangement with the piping trade

- c. Valve differential pressure rating shall be equal to or greater than the associated pump's head pressure. Valve trim (seat, disc, plug, ball, stem, etc.) materials and actuator torque shall be selected to close off against this differential pressure rating
- d. All valve actuators shall be electronic and sized to close off against 125% of the associated pump head pressure.
- e. Only one actuator shall be provided on each valve, regardless of valve type. Dual or tandem actuator mounting arrangements are not permitted.
- f. All valves in contact with propylene glycol shall have peroxide-cured EPDM.
- 3. Pressure Independent Modulating Chilled Water Valve:
 - a. All modulating chilled water control valves shall be pressure independent and provided with actuators. Pressure independent control valves shall deliver a near constant flow rate with rapid system differential pressure changes. Valves shall be configured with one integrated valve body that incorporates one chamber with an adjustable Cv and a separate pressure regulating chamber used to maintain a constant differential pressure across the control surface.
 - b. Each control valve size and model proposed to be provided on this project shall be individually flow tested at the factory and verified to deviate no more than $\pm 5\%$ at the operating pressures of 5, 35 and 65 PSID (at each 10-degree increment. All testing shall be performed with instruments calibrated to the requirements of ANSI/ISA-S75.11-1985, with traceability to NIST and/or ISO standards.
 - c. Submit manufacturer's flow testing documentation of the above testing from an independently owned third party testing agency for each valve size and model proposed to be provided on this project. All testing shall be performed with instruments calibrated to the requirements of ANSI/ISA-S75.11-1985, with traceability to NIST and/or ISO standards.
 - d. Valve body and trim shall provide the following performance requirements; ANSI Class 150 rated, ANSI/FCI 70-2 Class III or better leakage rating at 70 PSID (70 psi), all metal and Teflon internal trim and designed for 100:1 or better turndown.
 - e. There shall be three ports installed at the factory integral to each valve and capable of being used to measure pressure or temperature in the field. The first port shall be installed at the inlet to the valve. The second shall be installed between the Cv chamber and the pressure regulating chamber. The third shall be installed at the outlet of the valve. Should the ports not be provided as part of the valve body, then they shall be installed in a spool piece and attached to the body.
 - f. The differential pressure between the first and the third port shall be used to verify that the minimum differential pressure of 5 PSID (5 psi) required for pressure independent operation is available.
 - g. It shall be possible to verify the flow rate through the control valve using the valve stem position and the differential pressure measurement between the first and second ports on the valve. If these valve features are not provided, a flow meter shall be installed at each valve to verify the actual flow rate in operation through the valve.
 - h. Actuator: Regular Duty, Modulating Type
 - i. Product:
 - 1) Flow Control Industries, Inc.
 - 2) Delta P Valve
 - 3) no substitutions
- 4. 3-way modulating control valves:
 - a. Acceptable Manufacturers:
 - 1) Fisher
 - 2) Bray
- 5. Ball Valves for Fluid Service:

- a. Acceptable Manufacturers:
 - 1) Belimo – B2, B3, B6 Models
 - 2) Bray – ST2, STM Models
 - 3) Johnson Controls – VG1000 Models
 - 4) Honeywell – VBN Models
 - 5) Siemens – 599 Series
- b. Sizing:
 - 1) 2-way/3-way, two-position:
 - (a) Line size or size using a pressure differential of 1 PSID.
 - 2) 2-way/3-way, modulating:
 - (a) Valve size shall be no more than two pipe sizes less than the pipe size, i.e. a 1" (25mm) valve would not be acceptable in a 2" (1.97 inch) line, but a 1 1/4" (1.26 inch) valve would be.
 - (b) Flow Coefficient (Cv):
 - (1) Compute Cv based on 5 PSID or twice the load pressure drop, whichever is greater. Include pipe reduction effect when determining appropriate Cv.
 - (2) Hot Water Service: Select valve equal to or closest option less than computed Cv.
 - (3) Chilled Water Service: Select valve equal to or closest option greater than computed Cv.
- c. Valve Construction:
 - 1) Valve Body: forged brass or bronze
 - 2) Ball: stainless steel
 - (a) Modulating: equal percentage flow characteristic by any of the following methods; characterizing disc, parabolic port insert, or modified cut ball.
 - (b) Two position: full port unless scheduled otherwise.
 - 3) Stem: stainless steel, blow-out proof design, minimum two EPDM or MTFE O-rings backing
 - 4) Valve Seats and Seals: Teflon PTFE, EPDM
- d. End connections:
 - 1) 1/2" – 2" (0.5 inch - 1.97 inch)) - NPT
 - 2) 2-1/2" (2.5 inch) or larger - Flanged
- e. Pressure Ratings:
 - 1) Body static pressure minimum rating: 350 PSI (348 psi)
 - 2) Close-off minimum rating: 100 PSID (102 psi)
 - 3) Dynamic pressure rating: 50 PSID (51 psi)
- f. Leakage Rating:
 - 1) ANSI class IV (<0.1%)
- g. Temperature Rating:
 - 1) Fluid temperature: -22°F to 250°F (-30°C) to (121°C)
- h. Actuator Type:
 - 1) Two-Position: Regular Duty
 - 2) Modulating: Regular Duty
- 6. Regular Duty Butterfly Valves:
 - a. Acceptable Manufacturers:
 - 1) Jamesbury
 - 2) Xomox
 - 3) DeZurik
 - 4) Dodge Engineering & Controls, Inc.

- b. Valve Performance Requirements: ANSI Class 150 rated, ANSI raised face flanges, ANSI/FCI 70-2 Class IV leakage rating and bi-directional drip-tight shut to rated pressure, rated to 247 psi dead-end service.
 - c. Valve Body: fully lugged carbon steel and rated at ANSI 150 pressure rating for hydrostatic requirements. Flanges shall meet ANSI 125 and 150 standards.
 - d. Valve Trim: stainless steel for discs and stems, with both top and bottom alignment bearings for stems
 - e. Seats and Seals: Teflon, and suitable for the intended service
 - f. Valve Shaft: extended to clear pipe insulation by 2" (1.97 inch).
 - g. Actuator: Heavy-Duty Type:
 - 1) Isolation Valves: Two-Position Type
 - 2) Modulating Valves: Modulating Type
7. Globe Valves:
- a. Acceptable Manufacturers:
 - 1) Belimo
 - 2) Delta Control Products
 - 3) Dodge Engineering & Controls, Inc.
 - b. Valves 1/2" through 2" (0.51 inch through 1.97 inch): bronze body, rated for ANSI Class 250 pressure rating
 - c. Valves 2" through 6" (1.97 inch through 150 mm): cast iron or carbon steel body, rated for ANSI Class 125 or 250 working pressure, depending upon piping system rating
 - d. Valve Stem: stainless steel, with EPDM or Teflon packing depending upon temperature of fluid
 - e. Valve Plug: brass or stainless steel, depending upon temperature and differential pressure requirements.
 - f. Actuator: manufacturer assembled onto valve at factory
8. Globe Valves (steam only):
- a. Acceptable Manufacturers:
 - 1) Belimo
 - 2) Delta Control Products
 - 3) Dodge Engineering & Controls, Inc.
 - b. Valves 1/2" through 2" (13 mm through 50 mm): bronze body, rated for ANSI Class 250 pressure rating
 - c. Valves 2" through 6" (50 mm through 150 mm): cast iron or carbon steel body, rated for ANSI Class 125 or 250 working pressure, depending upon piping system rating
 - d. Valve Stem: stainless steel, with EPDM or Teflon packing depending upon temperature of fluid
 - e. Valve Plug: brass or stainless steel, depending upon temperature and differential pressure requirements.
 - f. Actuator: manufacturer assembled onto valve at factory
9. Regular Duty Valve Actuators:
- a. Acceptable Manufacturers:
 - 1) Belimo
 - 2) Honeywell
 - 3) Siemens
 - b. Modulating Type: electronic utilizing microprocessor controlled brushless DC motors
 - c. Two-Position Type: electronic utilizing microprocessor controlled brushless or brush DC motors
 - d. Mounting Arrangement:
 - 1) Rotational Type Valves: direct coupled, rotational type, no exceptions

- 2) Globe Valves: rotational type, no exceptions, with linkage kit or piston drive
- e. Spring Return / Failure Position:
 - 1) All Valves: fail-last-position unless noted otherwise
 - 2) Spring Return: where noted, by mechanical spring return feature, capacitor and battery return actuators shall be prohibited
 - 3) Spring return shall permit normally open or normally closed position operation of same actuator by configuration or mounting arrangement
- f. Required Features:
 - 1) External adjustable stops, to limit the travel in either direction
 - 2) Gear release to allow manual positioning (valves 19mm and larger only)
 - 3) Removable crank to override the spring return and control signal, and manually position the damper
 - 4) Visual position indicator
 - 5) Integral current limiting circuitry or microprocessor overload protection
- g. Modulating Actuators:
 - 1) Power Supply: 24 VAC or VDC, maximum 15 VA power consumption
 - 2) UL 873 listed
 - 3) Control Signal: 2-10 VDC or 4-20 mA. Floating signal shall be prohibited.
 - 4) Feedback Signal: Clamp position feedback signal of 2-10 VDC, independent of the input signal, may be used to parallel other actuators and provide true position indication
- h. Two-Position Actuators:
 - 1) Power Supply: 24 or 120 VAC (220 VAC)
 - 2) UL 873 listed
 - 3) Feedback Signals: adjustable open and closed position switches integral to actuator
 - 4) Quick Acting: where required by sequence, shall move full stroke within 20 seconds
- i. Actuator Manufacturer Warranty: Free of defects for a period of 2 years from the date of installation

MISCELLANEOUS DEVICES

5.01 CONTROL TRANSFORMERS:

- A. General Requirements:
 - 1. All transformers shall be UL listed recognized.
 - 2. Each transformer shall have an on/off switch on the primary power.
 - 3. Each transformer shall have a manually reset circuit breaker on the secondary power output.
 - 4. Refer to Section 1.4 C for additional requirements.
- B. Panel Mounted Class 1 & 2 Power Sources:
 - 1. May be used for powering actuators and control panel components.
 - 2. Provide general requirements stated above.
 - 3. Integral 120 VAC (220 VAC) convenience outlet, non-switched.
 - 4. LED indication of each 24 VAC output status.
 - 5. Primary and secondary screw terminals.
 - 6. Manufacturers:
 - a. Functional Devices, Inc. PSB40/100AB10

- b. Air Products & Controls T-PB Series.
- C. Enclosed Class 2 Power Sources:
 - 1. Required for powering terminal unit controllers.
 - 2. May be used for powering actuators and control panel components.
 - 3. Provide general requirements stated above.
 - 4. Integral 120 VAC (220 VAC) convenience outlet, non-switched.
 - 5. LED indication of each 24 VAC output status.
 - 6. Primary and secondary screw terminals.
 - 7. Metal enclosure.
 - 8. UL916 listed.
 - 9. Manufacturers:
 - a. Functional Devices, Inc. PSH300/500A for multiple outputs
 - b. Air Products & Controls T-PB Series for single output

5.02 POWER SUPPLIES:

- A. General Requirements:
 - 1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
 - 2. Panel mounted.
 - 3. Input: 120 VAC (220 VAC) $\pm 10\%$, 60 Hz. Output: 24 VDC.
 - 4. Line Regulation: $\pm 0.05\%$ for 10% line change.
 - 5. Load Regulation: $\pm 0.05\%$ for 50% load change.
 - 6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
 - 7. Provide an appropriately sized fuse and fuse block located next to power supply.
 - 8. Provide power disconnect switch next to power supply.
 - 9. Refer to Section 1.4 C for additional requirements

PART 3 EXECUTION

6.01 EXAMINATION

- A. Refer to 23 09 00 Examination

6.02 PREPARATION

- A. Refer to 23 09 00 Preparation

6.03 INSTALLATION

- A. Refer to 23 09 00 Installation for requirements applicable to This Section, in addition to the requirements of This Article

6.04 SITE QUALITY CONTROL

- A. Refer to 23 09 00 Site Quality Control

6.05 SYSTEM STARTUP

- A. Refer to 23 09 00 System Startup

6.06 ADJUSTING

- A. Refer to 23 09 00 Adjusting

6.07 CLEANING

- A. Refer to 23 09 00 Cleaning

6.08 CLOSEOUT ACTIVITIES

- A. Refer to 23 09 00 Closeout Activities

6.09 PROTECTION

- A. Refer to 23 09 00 Protection

6.10 MAINTENANCE

- A. Refer to 23 09 00 Maintenance

SECTION 230923

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. DDC Networks
 - 2. Common DDC Hardware Requirements
 - 3. Building Controllers (B-BC)
 - 4. Advanced Application Controllers (B-AAC)
 - 5. Application Specific Controllers (B-ASC)
 - 6. DDC Software

1.02 REFERENCE STANDARDS

- A. ASHRAE 135 - x.
- B. UL 864 - Control Units and Accessories for Fire Alarm Systems.
- C. UL 916 - Energy Management Equipment.
- D. Related Requirements
 - 1. Drawings and general provisions of the Contract, including the General Conditions and Supplementary Conditions apply to this section.
 - 2. Division 01 Specification Section
 - 3. HVAC Control Sections:
 - a. Section 23 09 00 – Common Work Results for HVAC Control
 - 1) Requirements common to all HVAC Control Sections
 - b. Section 23 09 13 – Instrumentation and Control Devices for HVAC
 - 1) Input devices, output devices, control valves, control dampers
 - c. Section 23 09 63 – Integrated Automation
 - 1) BAS computer hardware, BAS software
 - d. Section 23 09 93 – Sequence of Operations for HVAC Controls
 - 1) Sequence of Operations, Points Matrices
- E. System Description
 - 1. Microprocessor-based direct-digital controller hardware and software, for the direct control and monitoring of HVAC equipment and systems

1.03 SUBMITTALS

- A. Refer to 23 09 00 Submittals for requirements applicable to This Section, in addition to the requirements of This Article
- B. Product Data:
 - 1. Schedules:

- a. Control Point Schedules (each DDC controller): Include all used and unused / spare points, one row for each point, one column for each of the following attributes:
 - 1) Point ID Number
 - 2) Point Name
 - 3) Point Description
 - 4) Type
 - 5) Address
 - 6) Connected Device Identification.
- b. Terminal Unit Controller Schedule: One row for each terminal unit controller, one column for each of the following attributes:
 - 1) Line Number
 - 2) Room Number (location of room sensor / room served)
 - 3) Address
 - 4) Controller Tag / Name
 - 5) Terminal Unit Tag
 - 6) Terminal Unit Location
 - 7) Service (e.g. CV, VAV w/ RH, VAV Tracking Pair, etc...)
 - 8) System, (e.g. AHU-xx, REF-yy)
 - 9) Floor Plan Drawing Reference
 - 10) TUC Model (i.e. part no., application no., etc...)
 - 11) Box Size (nominal inch units)
 - 12) Inlet Size (actual inch units)
 - 13) Damper Rotation Angle
 - 14) Air Flow Sensor Flow Coefficient (nominal for submittal / actual for as-built)
 - 15) Actuator set-up (e.g. 0 signal = closed, etc...)
 - 16) Maximum Primary CFM
 - 17) Minimum Primary CFM
 - 18) Maximum Secondary Cooling CFM (FP-VAV only)
 - 19) Maximum Secondary Heating CFM (FP-VAV only)
 - 20) Minimum Secondary Occupied CFM (FP-VAV only)
 - 21) Associated Terminal Units (e.g. RHC-x, RP-y, RVAV-xx, etc...)

1.04 MAINTENANCE MATERIAL SUBMITTALS

PART 2 PRODUCTS

2.01 DDC NETWORKS

A. General Requirements

1. The direct digital control (DDC) defined in This Section shall utilize the BACnet protocol as defined by ANSI/ASHRAE 135-2012 for all communication between controllers, servers, and workstations.
2. The DDC defined in This Section shall utilize products tested according to ASHRAE 135.1-2013 and listed as compliant by the BACnet Testing Laboratories of BACnet International, unless tested and listed products are not available from any manufacturer for a particular application.

B. First Tier Network:

1. The first tier network shall be the Building Systems TCP/IP Ethernet network:
 - a. Structured cabling for the Owner's Network is defined by Division 27

- b. Active equipment for the Owner's Network, such as switches, routers, and firewalls, will be provided by Owner.
 - c. The network will be managed by Owner, and Owner will provision all required or optional network services, such as VLANs, Domains, Active Directory, SMTP servers, etc.
 2. There shall only be one single first tier network serving the entire building.
 3. The first tier network shall support the BAS software platform, including an application server, multiple operator workstations, and printers. Refer to Section 23 09 63 Integrated Automation for additional BAS requirements.
 4. The first tier network shall also support DDC controllers such as Building Controllers (B-BC) and Advanced Application Controllers (B-AAC).
 5. The first tier network shall provide communications transport among connected DDC controllers, and between connected DDC controllers and the BAS platform.
 6. The first tier network shall operate at 10/100/1000 Mbps. Devices connected to the first tier network shall support operation at 100 Mbps at minimum, preferably 100 Mbps.
 7. The first tier devices shall communicate via BACnet/IP, ASHRAE 135 Annex J unless noted otherwise.
 8. The first tier shall also support alternate communication protocols as required for interface to third-party devices, for support of Enterprise application connectivity, and for browser user interface.
 9. Advanced Application Controllers (B-AAC) are permitted to reside on the first tier.
 10. Components of the BAS under 23 09 63 shall reside on the first tier.
- C. Second Tier Network:
 1. Second tier networks shall provide either "Peer-to-Peer" serial communications to support DDC controllers such as Advanced Application Controllers (B-AAC) and Application Specific Controllers (B-ASC), and their interface to Building Controllers (B-BC).
 2. There shall be multiple second tier networks, quantity as required to support all connected devices.
 3. The second tier networks are provided under This Section.
 4. The second tier devices shall communicate via BACnet MS/TP, ASHRAE 135, on EIA-485 twisted shield cable, unless noted otherwise.
 5. The second tier networks shall operate at 78.6 kbps minimum. Devices connected to the second tier networks shall support 78.6 kbps operation.
 6. Each second tier network shall be connected to a Building Controller (B-BC).
 7. Data objects on an individual second tier network shall be capable of being shared over the first tier network to other second tier networks.
 8. Application Specific Controllers (B-ASC) shall reside on the second tier only.
 9. Advanced Application Controllers (B-AAC) are permitted to reside on the second tier.
- D. Third Tier Network:
 1. Third tier networks are sensor-level networks, providing manufacturer-specific support for connected sensor devices only, or are controller-specific networks, providing manufacturer-specific support between host controller and expansion I/O modules only.
 2. Third tier networks are not required under This Section, but are permitted.
 3. Each third tier network shall connect to only one controller maximum. Third tier networks shall not be used for communications between controllers.
- E. Gateways and Routers:
 1. Building Controllers (B-BC) and BACnet Routers shall be the only devices permitted to interface between first tier and second tier networks.

COMMON DDC HARDWARE REQUIREMENTS

3.01 SPARE CAPACITY

- A. Provide each Building Controller (B-BC), Advanced Application Controller (B-AAC), and Application Specific Controller (B-ASC) with sufficient internal memory for the specified control sequences, alarming and history trending and have at least 50% of the memory available for future use.
- B. Each B-BC and B-AAC shall have a minimum of ten percent on-board spare I/O point capacity for future point expansion. B-ASC do not require spare I/O capacity.
- C. The type of spares shall be in the same proportion as the implemented I/O functions of the controller, but in no case shall there be less than one spare I/O point for each implemented I/O type.
- D. Provide all processors, power supplies, communication controllers, and I/O point modules so that the implementation of a point only requires the addition of the appropriate point field wiring and device.

3.02 EXPANSION POINT MODULES

- A. Where the on-board point capacity of a B-BC or B-AAC cannot meet the specified application, provide point expansion point modules within the same local control panel.
- B. Point expansion modules shall communicate directly with the controller's processor on a dedicated third tier communication bus. Use of a first or second tier network for controller to expansion module communication is not allowed.
- C. Where point expansion modules are provided, adhere to Spare Capacity for points as specified. The future ability to add point expansion modules to a controller shall not be a substitution for on-board Spare Capacity – Spare Capacity shall be fully provided.
- D. The installation of remote input/output point modules outside the enclosure for the system or programmable controller shall not be permitted.

3.03 BUILDING CONTROLLERS (B-BC)

- A. General:
 - 1. B-BC shall be tested and listed by the BACnet Testing Laboratories of BACnet International as compliant with the B-BC profile.
 - 2. B-BC shall be capable of controlling major mechanical equipment and systems, when provided with on-board or local expansion I/O.
 - 3. B-BC shall be capable of executing global supervisory control strategies among other DDC controllers on the connected first or second tier networks.
 - 4. B-BC shall be capable of operating the connected equipment / system according to sequence of operation as stand-alone, without network connection, B-OWS availability, or other B-BC availability.
 - 5. B-BC shall be fully programmable from an Operator Workstation, and the applications shall remain resident in non-volatile memory within the B-BC.
- B. Communications Networks:
 - 1. First Tier: B-BC shall reside on the first tier network.
 - 2. Primary Second Tier: Each B-BC shall support a network of a minimum of 32 controllers on a second tier network, or as required by application.

3. Additional Second Tier: B-BC may provide multiple second tier network ports, and may provide network ports supporting alternate industry standard open protocols such as M-Bus, Modbus/RTU, LonWorks, DALI, and KNX/EIB when required for interface to systems and devices provided under other Sections.
 4. Third Tier: B-BC may provide a manufacturer-specific third-tier sensor network for connection of sensors. Third tier network shall not be used for remote I/O.
- C. Capabilities:
1. Processor: B-BC shall be microprocessor-based with a maximum program scan rate of 3 seconds. They shall be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers and power supplies. Controller size and capability shall be sufficient to fully meet the requirements of this specification, the sequence of operation, and the control points matrix.
 2. Memory: Each B-BC shall have sufficient memory to conform to the performance requirements, as specified below, to support its own operating system, databases, control programs and to provide continuous real-time polling and supervisory control for all connected second tier controllers.
 3. Hardware Real Time Clock: The B-BC shall have an integrated hardware based real time clock, capable of synchronizing to a master system clock, and capable of passing clock synchronization to all connected second tier controllers.
 4. Diagnostics: B-BC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The B-BC shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
 5. EMF Isolation: Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standards 587-1980.
 6. Power Failure: In the event of the loss of input power, there shall be sufficient reserve power to perform an orderly shut-down of the B-BC, to prevent the loss of database or operating system software. Non volatile memory shall be incorporated for all critical B-BC configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours without input power.
- D. Input / Output Point Functionality:
1. General
 - a. B-BC are not required to implement onboard input / output (I/O) points when used as a supervisory controller.
 - b. When B-BC are used to directly control equipment, the B-BC shall provide I/O in sufficient quantity that all field devices and sensors associated with that equipment or system connect to a single controller. It shall be prohibited to distribute control of a single system or equipment across multiple controllers, unless expressly noted otherwise.
 - c. I/O points shall be implemented locally only, either on-board the B-BC, or outboard as expansion modules within the same Local Control Panel. Remote I/O is prohibited.
 2. Input Points:
 - a. Universal inputs shall have a minimum of 12 bit A/D resolution and shall monitor the following analog and binary signals:
 - 1) Thermistors and RTDs of standard curves.
 - 2) 4-20 mA Sensors.
 - 3) 0-10 VDC Sensors.
 - 4) Dry (Voltage-Free) Contact Closures.

- 5) Pulse Counter and Accumulation with a maximum frequency of 40 Hz.
- b. Inputs shall provide over-voltage and over-current (i.e. short) protection.
- c. Inputs shall provide optional software filtering or signal conditioning to eliminate false signals resulting from input "bouncing".
- d. Provide local LED for status indication of each binary input point.
- 3. Output Points:
 - a. Analog outputs shall have a minimum of 8 bit D/A resolution and shall provide the following control outputs:
 - 1) 4-20 mA - Sink or Source, capable of sourcing 75mA at 12VDC.
 - 2) 0-10 VDC.
 - 3) Floating type analog outputs are prohibited for valve and actuator applications unless noted otherwise.
 - b. Binary outputs shall provide SPDT (Form-C) output contacts rated for 2 amps minimum at 24 VAC. Provide pilot relays when required to meet this requirement. Provide local LED for status indication of each binary output point. Inductive loads shall always be controlled by pilot relays.
 - c. Outputs shall provide over-voltage and over-current (i.e. short) protection.
- 4. Manual Override Switches:
 - a. Provide the ability to manually override each controller's binary and analog output points.
 - 1) Manual override switches shall allow Hand, Off, and Auto control of the output using an accessible switch. Jumper type overrides are not acceptable.
 - 2) Analog outputs shall include rotary potentiometers with graduated scale to control the output value in Hand mode.
 - b. Manual override switches shall be independent of the controller's processor and function when the processor has failed or is off-line. Software override using onboard LCD or remote Operator Display are not permitted substitutes for HOA switches.
 - c. Each manual override switch shall be monitored by the controller such that an override not in the automatic position (e.g. hand and off) is specifically indicated.
 - d. B-BC shall collect override status of all output points and provide a summary report on the operator workstation of all override activity.

3.04 ADVANCED APPLICATION CONTROLLERS (B-AAC)

A. General:

- 1. B-AAC shall be tested and listed by the BACnet Testing Laboratories of BACnet International as compliant with the B-AAC profile.
- 2. B-AAC shall be capable of controlling small to medium sized mechanical equipment and systems, when provided with on-board or local expansion I/O.
- 3. When B-AAC does not have on-board or local expansion I/O capacity for an application, provide B-BC for that application.
- 4. B-AAC shall be capable of operating the connected equipment / system according to sequence of operation as stand-alone, without network connection, B-OWS availability, or B-BC availability.
- 5. B-AAC shall be fully programmable from an Operator Workstation, and the applications shall remain resident in non-volatile memory within the B-AAC.

B. Communications Network:

- 1. First / Second Tier: B-AAC may reside on the first tier or second tier network.

2. No Routing: B-AAC may provide multiple physical media or protocol choices at start-up time, but B-AAC shall not support multiple simultaneous functional networks, nor any routing or gateway (protocol translation) functions. Where multiple networks, routing, or protocol translation is required, provide B-BC for that application.
3. Third Tier: B-AAC may provide a manufacturer-specific third-tier sensor network for connection of sensors. Third tier network shall not be used for remote I/O.

C. Capabilities:

1. Processor: B-AAC shall be microprocessor-based with a maximum program scan rate of 3 seconds. They shall be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers and power supplies. Controller size and capability shall be sufficient to fully meet the requirements of this specification, the sequence of operation, and the control points matrix.
2. Memory: Each B-AAC shall have sufficient memory to conform to the performance requirements, as specified below, to support its own operating system, databases, and control programs.
3. Hardware Real Time Clock: The B-AAC shall have an integrated hardware based real time clock, capable of synchronizing to a B-BC or B-OWS.
4. Diagnostics: B-AAC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The B-AAC shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
5. EMF Isolation: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.
6. Power Failure: In the event of the loss of input power, there shall be sufficient reserve power to perform an orderly shut-down of the B-AAC to prevent the loss of database or operating system software. Non volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours without input power.
 - a. During a loss of power, the control sequences shall go to the normal system shut-down conditions, unless otherwise specified in a Sequence of Operation.
 - b. Upon restoration of power, after a minimum off time delay, the B-AAC shall automatically resume full operation without manual intervention through a normal soft-start sequence. Reference Sequence of Operation for additional requirements.
 - c. Should a B-AAC memory be lost for any reason, the system shall automatically reload the program transparently and without any intervention by building personnel.
 - d. Building personnel shall have the capability of manually reloading the B-AAC from the operator workstation across intermediary networks.

D. Input / Output Point Functionality:

1. General
 - a. B-AAC shall provide I/O in sufficient quantity that all field devices and sensors associated with that equipment or system connect to a single controller. It shall be prohibited to distribute control of a single system or equipment across multiple controllers, unless expressly noted otherwise.
 - b. I/O points shall be implemented locally only, either on-board the B-AAC, or outboard as expansion modules within the same Local Control Panel. Remote I/O is prohibited.
2. Input Points:
 - a. Universal inputs shall have a minimum of 12 bit A/D resolution and shall monitor the following analog and binary signals:

- 1) Thermistors and RTDs of standard curves.
 - 2) 4-20 mA Sensors.
 - 3) 0-10 VDC Sensors.
 - 4) Dry (Voltage-Free) Contact Closures.
 - 5) Pulse Counter and Accumulation with a maximum frequency of 40 Hz.
 - b. Inputs shall provide over-voltage and over-current (i.e. short) protection.
 - c. Inputs shall provide optional software filtering or signal conditioning to eliminate false signals resulting from input "bouncing".
 - d. Provide local LED for status indication of each binary input point.
3. Output Points:
 - a. Analog outputs shall have a minimum of 8 bit D/A resolution and shall provide the following control outputs:
 - 1) 4-20 mA - Sink or Source, capable of sourcing 75mA at 12VDC.
 - 2) 0-10 VDC.
 - 3) Floating type analog outputs are prohibited for valve and actuator applications unless noted otherwise.
 - b. Binary outputs shall provide SPDT (Form-C) output contacts rated for 2 amps minimum at 24 VAC. Provide pilot relays when required to meet this requirement. Provide local LED for status indication of each binary output point. Inductive loads shall always be controlled by pilot relays.
 - c. Outputs shall provide over-voltage and over-current (i.e. short) protection.
4. Manual Override Switches:
 - a. Provide the ability to manually override each controller's binary and analog output points.
 - 1) Manual override switches shall allow Hand, Off, and Auto control of the output using an accessible switch. Jumper type overrides are not acceptable.
 - 2) Analog outputs shall include rotary potentiometers with graduated scale to control the output value in Hand mode.
 - b. Manual override switches shall be independent of the controller's processor and function when the processor has failed or is off-line. Software override using onboard LCD or remote Operator Display are not permitted substitutes for HOA switches.
 - c. Each manual override switch shall be monitored by the controller such that an override not in the automatic position (e.g. hand and off) is specifically indicated.
 - d. B-AAC shall collect override status of all output points and provide a summary report on the operator workstation of all override activity.

3.05 APPLICATION SPECIFIC CONTROLLERS (B-ASC)

A. General:

1. B-ASC shall be tested and listed by the BACnet Testing Laboratories of BACnet International as compliant with the B-ASC profile.
2. B-ASC shall be capable of controlling fixed-profile terminal unit and small-sized mechanical equipment / systems with on-board I/O, and may provide integral sensors and integral actuators.
3. When B-ASC does not have on-board I/O capacity for an application, provide B-AAC or B-BC for that application.
4. B-ASC shall be capable of operating the connected equipment / system according to sequence of operation as stand-alone, without network connection, B-OWS availability, B-AAC, or B-BC availability.

5. B-ASC may be fully programmable from an Operator Workstation, or may provide a fixed configurable application. The application and configurations shall remain resident in non-volatile memory within the B-ASC. When B-ASC with a fixed configurable application cannot meet the design sequence of operations, provide a fully programmable B-ASC, a B-AAC, or a B-BC for that application.
- B. Communications Network:
1. First / Second Tier: B-ASC shall reside on the second tier unless expressly noted otherwise. If first tier B-ASC are considered as an alternate or substitute, the additional cost of structured cabling systems and active network electronics (i.e. switches) shall be included in the pricing.
 2. Third Tier: B-ASC may provide a manufacturer-specific third-tier sensor network for connection of sensors. Third tier network shall not be used for remote I/O.
- C. Capabilities:
1. Processor: B-ASC shall be microprocessor-based with a maximum program scan rate of 3 seconds. They shall be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers and power supplies. Controller size and capability shall be sufficient to fully meet the requirements of this specification, the sequence of operation, and the control points matrix.
 2. Memory: Each B-ASC shall have sufficient memory to conform to the performance requirements, as specified below, to support its own operating system, databases, and control programs.
 3. Hardware Real Time Clock: The B-ASC shall have an integrated hardware based real time clock, capable of synchronizing to a B-BC, B-AAC, or B-OWS.
 4. Diagnostics: B-ASC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The B-ASC shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
 5. EMF Isolation: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.
 6. Power Failure: In the event of the loss of input power, there shall be sufficient reserve power to perform an orderly shut-down of the B-ASC to prevent the loss of database or operating system software. Non volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours without input power.
 7. Onboard Sensors and Actuators: B-ASC may contain onboard sensors or actuators, provided that each onboard device meets the applicable specifications for the device type.
- D. Input / Output Point Functionality:
1. General
 - a. B-ASC shall provide I/O in sufficient quantity that all field devices and sensors associated with that equipment or system connect to a single controller. It shall be prohibited to distribute control of a single system or equipment across multiple controllers, unless expressly noted otherwise.
 - b. I/O points shall be implemented locally only, either on-board the B-ASC, or outboard as expansion modules within the same Local Control Panel. Remote I/O is prohibited.
 2. Input Points:

- a. Universal inputs shall have a minimum of 10 bit A/D resolution and shall monitor the following analog and binary signals:
 - 1) Thermistors and RTDs of standard curves.
 - 2) 4-20 mA Sensors.
 - 3) 0-10 VDC Sensors.
 - 4) Dry (Voltage-Free) Contact Closures.
 - 5) Pulse Counter and Accumulation with a maximum frequency of 40 Hz.
- b. Inputs shall provide over-voltage and over-current (i.e. short) protection.
- c. Inputs shall provide optional software filtering or signal conditioning to eliminate false signals resulting from input "bouncing".
- d. Provide local LED for status indication of each binary input point.
- 3. Output Points:
 - a. Analog outputs shall have a minimum of 8 bit D/A resolution and shall provide the following control outputs:
 - 1) 4-20 mA - Sink or Source, capable of sourcing 75mA at 12VDC.
 - 2) 0-10 VDC.
 - 3) Floating type analog outputs are prohibited for valve and actuator applications unless noted otherwise.
 - b. Binary outputs shall provide SPDT (Form-C) or SPST Triac output contacts rated for 2 amps minimum at 24 VAC. Provide pilot relays when required to meet this requirement. Provide local LED for status indication of each binary output point. Inductive loads shall always be controlled by pilot relays. Field controls which are subject to an open circuit condition shall always be controlled by pilot relays when driven by Triac output.
 - c. Outputs shall provide over-voltage and over-current (i.e. short) protection.

E. DDC SOFTWARE

- 1. General Requirements
 - a. The software control language(s) used in all digital controllers shall provide point identifications which are a minimum of 12 alpha/numeric characters in length.
 - b. All process set points, time delays and similar parameters identified as adjustable in the sequence of operations or on the control point matrix shall accessible for adjusting through the OWS without the need for editing or recompiling the program source code.
 - c. There shall be a maximum of two (2) programming application environments (also known as software tool, programming tool, or programming language) used by the BAS.
 - 1) The fully programmable application environment used by B-BC and B-AAC.
 - 2) The configuration application environment used by B-ASC.
 - 3) Alternately, the B-BC may use one application environment, while the B-AAC and B-ASC share an environment, provided that all requirements below are met.
 - 4) The application environments may be integral to the OWS software, or may be provided as separate software applications. Regardless, it shall be possible to operate all application environments as well as the OWS software on each OWS and portable OWS computer. It shall additionally be possible to connect with all DDC controllers across the first and second tier networks, for point interrogation, configuration adjustment, and application download from an OWS. Direct connection to a controller shall not be required.
- 2. Fully Programmable Application Environment:
 - a. General Requirements:

- 1) All necessary software, operating systems, and firmware to form a complete and operating direct digital controller as described in this specification shall be provided and shall reside solely within each individual controller.
- 2) Execution of the control program within each controller shall be completely independent of other computers or controllers for execution, except where specific software variables are required from the network, such as outside air temperature.
- 3) The fully programmable application environment shall be used to create, debug, compile, and download control programs into the individual controllers. It shall also be used to update controller firmware, when necessary.
- b. Control Program Capabilities:
 - 1) Controllers shall execute custom, job-specific control programs, to automatically perform calculations and special control routines in order to operate the connected equipment according to sequence of operation.
- c. Application Environment:
 - 1) Control programs shall be authored in a graphical object-based environment. While line code may be utilized to create scripts or sub-routines, line code shall not be the primary method of control program authoring.
 - 2) The application environment shall at all times store the source code (i.e. human-readable version) of the control program, to be used for future editing. The source code shall remain on the local storage of an OWS, and will remain property of the project Owner. Program obfuscation, removal of source code from project site, or local storage of only the compiled binary files shall not be accepted.
 - 3) Program source code shall allow for unlimited comments for documentation of software function and use by the programmer.
 - 4) The application environment shall include online documentation and online tutorials to assist in developing programming skills.
 - 5) The application environment must be simple and concise in use. It must provide a complete library of common logic and programming functions as building blocks for control program development.
 - 6) The application environment must permit the creation of custom groups of functions which are commonly repeated throughout the project. These groups or templates shall be saved to a library for future reuse.
- d. Schedules:
 - 1) Controllers shall provide user definable schedules as follows:
 - (a) Weekly schedules with multiple Start/Stop times for each day of the week.
 - (b) Temporary weekly override schedules.
 - (c) Special override schedules for specific user selectable calendar dates.
 - (d) Holiday scheduling, including floating holidays.
 - 2) Weekly schedules shall be provided for each piece of equipment with a specific time use schedule. Each schedule shall include start and stop times for each day of the week. Multiple weekly schedules may be grouped together to control a single piece of equipment or equipment group.
 - 3) It shall be possible to define one or more master holiday schedules to allow the operator to define in one location the holidays for all associated schedules. Systems requiring the operator to change holiday definitions on a schedule by schedule basis shall not be accepted.
 - 4) Standard weekly schedules shall be inactive on a holiday. The system shall allow the user to include in a schedule group a schedule which will only be active if today is a holiday.

- 5) Temporary weekly overrides schedules may be inserted into schedule groups for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.
- 6) Schedules shall be provided for each system, or sub-system in the facility. Each schedule shall include all commandable points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system.
- 7) Special days shall automatically reschedule equipment operation as previously defined on the weekly schedules on a specific calendar date.
- e. Historical Data Collection: Historical data collection utilities shall be provided to automatically sample, store and display system data for points as specified.
 - 1) Each controller shall store point history data for all analog and digital inputs and outputs as follows:
 - (a) Any point, physical or calculated may be designated for trending. Two methods of collection shall be provided:
 - (1) Pre-defined time interval.
 - (2) Upon a change of value.
 - (3) Sample intervals of 1 controller scan to 7 days shall be provided.

Each system controller shall have a dedicated RAM-based buffer for trend data and shall store a minimum of 96 samples for each physical point and software variable, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
 - (b) Trend and change of value data shall be stored within the controller and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either a user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in 3rd party personal computer applications such as Excel via a single command data export utility.
 - (c) Provide formatted trend report displays for each point. Include all trend data and associated parameters.
 - (d) Provide preformatted commands to view and print trend reports.
- f. Alarms: Alarm management shall be provided to monitor and direct alarm information to operator devices. Each controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the controller ability to report alarms be affected by either operator activity at a workstation, local I/O device or communications with other panels on the network.
 - 1) All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
 - 2) The user shall be able to define the specific system reaction for each point. Each alarm shall have user definable destination categories (e.g. PC, printer, system controller, pager, etc.) to provide full flexibility in defining the handling of system alarms. Each system controller shall automatically inhibit the reporting of selected alarms during system shut-down and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The contractor shall request from the Owner a configuration list for all alarms to be activated for the system and shall configure the initial alarms as requested. After configuring the initial alarms, the Contractor shall train the building operators on the use and configuration of the alarm system. After the training has been completed the

- building operators shall be responsible for alarm management and configuration.
- 3) Alarm reports and messages will be directed to a user-defined list of operator devices and/or workstations.
 - 4) In addition to the point's descriptor and the time and date, each system controller shall store a library of at least 50 custom alarm messages. Each message may be assignable to any number of points in the controller. The alarm message shall be a minimum of 60 characters.
 - 5) Operator-selected alarms shall initiate an e-mail message via the Internet to remote operator devices, such as digital PDAs, digital pagers and PCs.
 - 6) Local Alarms
 - (a) The controller shall provide alarm monitoring for all analog input values that are outside of user definable ranges, for all binary alarm status points and for all binary output points that do not prove status based on a paired binary input status point. The user shall be able, from the operator workstation, to configure the alarm limit ranges, limit dead-bands and to enable/disable the alarm.
 - (b) The user shall be able to configure any controller alarm as a conditional alarm that will only occur when a selected binary point is ON or OFF. This shall be used to prevent nuisance alarms during non-operating and/or system startup modes.
 - (c) Temperature alarms shall be operator configured to alarm based on:
 - (d) An operator adjustable alarm dead band which shall generate a warning or alarm whenever the temperature is above the current active set point plus the alarm dead band or below the current active set point minus the alarm dead band.
 - (e) High and Low alarm limit set points with either return to normal values or dead bands.
 - g. Controllers shall automatically accumulate and store run-time hours for all digital input and output points.
 - 1) The totalization routine shall have a sampling resolution of one minute or less.
 - 2) The user shall have the ability to define a warning limit for run-time totalization for each point. Unique, user-specified messages shall be generated when the limit is reached.
 - 3) Provide a formatted report display for each point showing all calculated data and associated parameters.
 - h. Controller shall automatically accumulate and store the Average, Minimum and Maximum values for all Analog input and output points.
 - 1) Provide a formatted report display for each point showing all calculated data and associated parameters.
 - i. Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly and monthly basis for all analog and digital pulse type inputs monitoring flow, KW, KWH, etc.
 - 1) Totalization shall provide calculation and storage of accumulations of up to 99,999 units (e.g. KWH, gallons, BTU, tons, etc.)
 - 2) The totalization routine shall have a sampling resolution of one minute or less.
 - 3) The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
 - 4) Provide a formatted report display for each point showing all calculated data and associated parameters.
3. Application Specific Controller Programming Environment
 - a. General:

- 1) B-ASC shall be specifically manufactured to control HVAC terminal devices and unitary equipment such as VAV Terminals, Heat Pump, Fan Coils, etc.
 - 2) All software operating parameters shall be available to the B-BC and to all B-OWS.
 - 3) Configuration of the B-ASC shall be performed from the B-OWS across the networks.
 - 4) B-ASC shall provide temperature control accuracy from -1°F (-0.5°C) below heating set point to +1°F (+0.5°C) above cooling set point. Controller shall provide a dead-band to prevent short cycling between heating and cooling modes.
 - 5) The operator workstation software shall make permanent parameter value changes without having to reload the controller program or configuration file. Permanent parameter value changes shall not interfere with normal temperature control operation.
- b. Programming Environment:
- 1) The B-ASC may use either the primary programming language or a 'wizard' question and answer tool that allows the operator to select a predefined operating sequence (for example: VAV with 2 stages of reheat) and use a forms type editor to "fill in the blanks" to set all required parameters to make the controller fully functional.
 - 2) The user shall be able to select the operating personality for a B-ASC from a B-OWS.
- c. Schedules:
- 1) B-ASC shall provide an internal scheduling system. The system shall be supported by the controller's hardware or software clock and shall operate in a stand-alone mode when isolated from network communications.
 - 2) The system shall provide for a minimum of three different operating periods per day. These periods may be assigned to; Morning Warm-up, Morning Cool-down, Night Setback, Unoccupied or Occupied sequences.
 - 3) Each operating period shall have individual start/stop times for each day of the week and shall have individual heating and cooling set points to be used as the active set points during that period.
 - 4) The supervising B-BC and B-OWS shall read and write schedules within the B-ASC.
 - 5) The operator shall be able to group controllers into a common schedule group. Modifications to shared schedules for the group shall be automatically downloaded to each terminal unit controller.
- d. Historical Data Collection:
- 1) For B-ASC which do not provide history data collection internally, all points shall be trended within the supervising B-BC.
 - (a) Trends of B-ASC points within a B-BC shall conform to the general specifications for trends within system or network controllers.
 - (b) Each analog input shall collect 96 samples within a first-in first-out rotating buffer.
 - (c) Each binary input and output shall collect 24 change in value samples.
 - (d) Each sample shall include a time/date stamp.
 - 2) For B-ASC that provide internal historical data collection, they shall provide the following:
 - (a) Each analog input shall collect 96 samples within a first-in first-out rotating buffer.
 - (b) Each binary input and output shall collect 24 change in value samples.
 - (c) Each sample shall include a time/date stamp.

- 3) Provide formatted trend report displays for each point. Include all trend data and associated parameters.
- 4) Provide preformatted commands to view and print trend reports.
- e. Alarms:
 - 1) Network Alarms
 - (a) The supervising B-BC shall monitor the local alarms within each B-ASC and shall initiate a network alarm in response.
 - (b) Supervised alarms shall conform to all alarm requirements as specified in the B-BC sections.
 - 2) Local Alarms
 - (a) The B-ASC shall provide alarm monitoring for analog input values that are outside of user definable ranges and for binary output points that do not prove status.
 - (b) The user shall be able, from the operator workstation, to configure the limit ranges, limit dead-bands and to enable/disable each alarm.
 - (c) Zone temperature alarms shall have an operator adjustable alarm dead-band which shall generate a warning or alarm whenever the zone temperature is above the current active cooling set point plus the alarm dead-band or below the current active heating set point minus the alarm dead-band. Systems which do not allow linking of alarm set points with the active control set points shall not be accepted.
 - (d) The user shall be able to configure B-ASC alarms as conditional alarms that will only occur when a binary status point, physical or software, is on. This shall be used to prevent nuisance alarms during non-operating or startup modes.

PART 3 EXECUTION

4.01 EXAMINATION

- A. Refer to 23 09 00 Examination

4.02 PREPARATION

- A. Refer to 23 09 00 Preparation for requirements applicable to This Section

4.03 INSTALLATION

- A. Refer to 23 09 00 Installation for requirements applicable to This Section, in addition to the requirements of This Article
- B. Local Control Panels:
 1. Provide Local Control Panels to house all B-BC and B-AAC, minimum one per room, minimum one per major plant equipment such as air handling unit.
 2. Install all B-AAC and B-ASC serving unitary and terminal unit equipment in control enclosures integral to the parent equipment. If no integral control enclosure exists on the parent equipment, provide Local Control Panel to house each controller.

4.04 SITE QUALITY CONTROL

- A. Refer to 23 09 00 Site Quality Control for requirements applicable to This Section

4.05 SYSTEM STARTUP

- A. Refer to 23 09 00 System Startup for requirements applicable to This Section

4.06 ADJUSTING

- A. Refer to 23 09 00 Adjusting for requirements applicable to This Section

4.07 CLEANING

- A. Refer to 23 09 00 Cleaning for requirements applicable to This Section

4.08 CLOSEOUT ACTIVITIES

- A. Refer to 23 09 00 Closeout Activities for requirements applicable to This Section

4.09 PROTECTION

- A. Refer to 23 09 00 Protection for requirements applicable to This Section

4.10 MAINTENANCE

- A. Refer to 23 09 00 Maintenance for requirements applicable to This Section

SECTION 230934

VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.
- B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

- A. Section 230529 - Hangers and Supports for HVAC Piping and Equipment.
- B. Section 230553 - Identification for HVAC Piping and Equipment: Identification products and requirements.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives.
- B. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems.
- C. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems.
- D. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems.
- E. NEMA MG 00001 - Motors and Generators.
- F. NFPA 70 - National Electrical Code.
- G. UL 508A - Industrial Control Panels.
- H. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
 - 2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
 - 3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.

5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.
 2. Include wiring diagrams showing factory and field connections.
- D. Specimen Warranty: Submit sample of manufacturer's warranty.
- E. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
 1. Authorized service facilities located within 50 miles of project site.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ABB; _____: www.abb.com/#sle.
- B. Danfoss: www.danfoss.com/#sle.

- C. Yaskawa America, Inc; : www.yaskawa.com/#sle.
- D. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Basis of Design is ABB ACH580.
- B. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- C. Provide products listed, classified, and labeled as suitable for purpose intended.
- D. Variable-Frequency Motor Controller:
 - 1. Configuration: Packaged controller, nonbypass.
 - 2. Power Conversion System: Diode-based, 6-pulse type.
 - 3. Control Method: Vector; open-loop, without feedback.
 - 4. Filtering: Provide input/line reactor and output/load reactor.
 - 5. Input/Output Connections: _____.
 - 6. Features:
 - a. Braking chopper/resistor.
 - b. PID control.
 - c. Safety interlock.
- E. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- F. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
 - 1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
 - 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
 - 3. Motor nameplate data.
 - 4. Requirements for speed control range, speed regulation, and braking.
 - 5. Motor suitability for bypass starting method, where applicable.
- G. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- H. Operating Requirements:
 - 1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
 - 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
 - 3. Efficiency: Minimum of 96 percent at full speed and load.
 - 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
 - 5. Overload Rating:
 - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
 - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- I. Power Conversion System: Microprocessor-based, pulse width modulation type.

1. Diode-based, 6-pulse type unless otherwise indicated.
- J. Control System:
 1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
 2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
 3. Control Functions:
 - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
 - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
 - 2) Vector Control: Provide selectable autotuning function.
 - b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
 - c. Adjustable minimum/maximum speed limits.
 - d. Adjustable pulse width modulation switching carrier frequency.
 - e. Adjustable motor slip compensation.
 - f. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
 4. Status Indications:
 - a. Motor run/stop status.
 - b. Motor forward/reverse status.
 - c. Local/remote control status.
 - d. Output voltage.
 - e. Output current.
 - f. Output frequency.
 - g. DC bus voltage.
 - h. Motor speed.
 - i. Speed reference.
 - j. Instantaneous power.
 - k. Energy.
 - l. Elapsed run time.
 - m. Controller temperature.
 - n. Discrete input/output status.
 - o. Analog input/output values.
 5. Protective Functions/Alarm Indications:
 - a. Overcurrent.
 - b. Motor overload.
 - c. Undervoltage.
 - d. Overvoltage.
 - e. Controller overtemperature.
 - f. Input/output phase loss.
 - g. Output short circuit protection.
 - h. Output ground fault protection.
 - i. Motor stalled/overtorque.
 - j. Motor underload.

- k. External fault.
- 6. Inputs:
 - a. Digital Input(s): Three.
 - b. Analog Input(s): Two.
- 7. Outputs:
 - a. Analog Output(s): One.
 - b. Relay Output(s): Two.
- 8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
 - a. Serial Communications: RS-485; support for BACnet MS/TP protocol.
 - b. Remote Monitoring Capabilities:
 - 1) Motor run/stop status.
 - 2) Hand-off-auto status.
 - 3) Fault information.
 - 4) Discrete input/output status.
 - 5) Analog input/output values.
 - c. Remote Control Capabilities:
 - 1) Motor run/stop command.
 - 2) Hand-off-auto selection.
 - 3) Speed adjustment.
- K. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
 - 1. Disconnects: Circuit breaker or disconnect switch type.
 - a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
 - b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 - 2. Provide door-mounted remote operator interface.
- L. Products:
 - 1. ABB; ACH580: www.abb.com/#sle.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
- C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 230529.
- F. Install controllers plumb and level.

- G. Provide grounding and bonding in accordance with Section 260526.
- H. Install field-installed devices, components, and accessories.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.02 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.03 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
- D. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's authorized representative.
 - 4. Location: At project site.

3.04 PROTECTION

- A. Protect installed controllers from subsequent construction operations.

3.05 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 4 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

SECTION 230963
INTEGRATED AUTOMATION

PART 1 GENERAL

1.01 SUMMARY VV

- A. Section Includes
 - 1. BAS Application Server Computer
 - 2. BAS Operator Workstation (OWS) Computer
 - 3. BAS Portable Laptop Computer
 - 4. BAS Printers
 - 5. BAS Software
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including the General Conditions and Supplementary Conditions apply to this section.
 - 2. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
 - 3. Division 01 Specification Section
 - 4. The Network may be an important related section, and may be provided by Owner (FFE), by Division 27, or by a related HVAC Control Section. Update as needed.
 - 5. HVAC Control Sections:
 - a. Section 23 09 00 – Common Work Results for HVAC Control
 - 1) Requirements common to all HVAC Control Sections
 - b. Section 23 09 13 – Instrumentation and Control Devices for HVAC
 - 1) Input devices, output devices, control valves, control dampers
 - c. Section 23 09 23 – Direct-Digital Control System for HVAC
 - 1) DDC networks, DDC controllers, DDC software
- C. ADMINISTRATIVE REQUIREMENTS
- D. Refer to 23 09 00 Administrative Requirements for requirements applicable to This Section, in addition to the items of This Article.

1.02 UPDATE COORDINATION WITH OWNER'S IT DEPARTMENT FOR SPECIFIC PROJECT.

- A. Coordination:
 - 1. Owner's Information Technology Department: coordinate computer hardware and software with Owner's IT/IS department, for compatibility with the Owner's Enterprise Network and Operating Systems.
- B. SUBMITTALS
 - 1. Refer to 23 09 00 Submittals for requirements applicable to This Section
 - 2. Required Submittals:
 - a. Product Data: Each product
 - b. Bill of Materials: All products
 - 3. Technology Submittals:

- a. Certain technology products under This Section require final product submittals no more than three months prior to delivery to site
- b. Provide initial product submittals for all items as part of complete project submittal package.
- c. Resubmit Product Data for the following technology products no more than three months prior to delivery to site, highlighting each changed specification or noted as "no changes."
 - 1) BAS Application Server Computer
 - 2) BAS Operator Workstation Computer
 - 3) BAS Portable Laptop Computer
 - 4) BAS Printers

C. CLOSEOUT SUBMITTALS

1. Refer to 23 09 00 Closeout Submittals for requirements applicable to This Section, in addition to the requirements of This Article
2. File all Closeout Submittals, from this and all related Sections, electronically within the BAS for web browser-based on-line access by any BAS user
3. Required Closeout Submittals:
 - a. Manufacturer's Operation and Maintenance Manuals: Each product
 - b. Custom Operation and Maintenance Manual for BAS System, including the following documentation:
 - 1) Table of Contents.
 - 2) System Architecture Diagrams.
 - 3) General description and cut sheets for all components.
 - 4) Complete trouble-shooting procedures and guidelines.
 - 5) Complete operating instructions for all systems and software.
 - 6) Maintenance Instructions: Document all maintenance and repair / replacement procedures. Provide ordering
 - 7) Appendix A: Sample printouts of all; Reports, Group Listings and Alarm Messages.
 - 8) Appendix B: Printed listing of all BAS components and sub-system devices. Include Name, ID Number, Description, Where Located, Manufacturer and Model Number, Physical Network Port Connected To, IP Address / Mask / Gateway, and Current Firmware Version
 - c. System Warranty Documentation: According to 23 09 00 Warranty requirements
 - d. Product Warranty Documentation: Each product, as provided by manufacturer
 - e. Record Documentation: According to 23 09 00 Record Documentation
 - f. Software Applications on removable media (USB, CD/DVD): Each application.

1.03 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to 23 09 00 Maintenance Material Submittals for requirements applicable to This Section
- B. QUALITY ASSURANCE
- C. Refer to 23 09 00 Quality Assurance for requirements applicable to This Section
- D. Remove Delivery, Storage, and Handling if unused

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Refer to 23 09 00 Delivery, Storage, and Handling for requirements applicable to This Section

1.05 SITE CONDITIONS

- A. Refer to 23 09 00 Site Conditions for requirements applicable to This Section

1.06 WARRANTY

- A. Warrant the Products and Workmanship under This Section as a complete system along with the Products and Workmanship under other related Sections, according to 23 09 00 Warranty - Vendor Warranty.

PART 2 PRODUCTS

2.01 TEMPORARY NETWORK

- A. Furnish and install a temporary BAS network, including network cabling and hubs/switches, to provide automatic control of heating and cooling during construction. Temporary network may consist of copper cabling, fiber optic cabling, and/or 802.11 wireless networking.
- B. Cut-over all BAS network devices from temporary BAS cabling and hubs/switches, to permanent Owner network, when Owner network is available. Coordinate network requirements with Owner. Re-patch all BAS network devices. Readdress all BAS network devices as required by Owner.
- C. Remove all temporary cabling and devices after cut-over.

BAS INTEROPERABILITY

3.01 DATA COMMUNICATION INTERFACES

- A. The BAS shall provide two way data communications between the DDC controllers and other equipment manufacturer's unit-mounted controllers (UMC), such as but not limited to, chillers, boilers, adjustable speed drives, air flow measuring stations, water flow meters, PLCs, etc.
- B. The BAS shall include data communications interfaces (various protocols and media) as required by the UMC manufacturer.
- C. It shall be the responsibility of the Work under This Section to coordinate with the equipment manufacturers of this and other Sections immediately after contract award to provide functional data communications connections.
- D. Unless noted otherwise in a points matrix or sequence of operations, all available data provided by a UMC shall be mapped into the BAS, and shall be displayed on color graphic screens at the Operator Workstation.
- E. Each UMC indicated may utilize one of the following acceptable methods of interoperability:
 - 1. BACnet MS/TP: Include BAS networks, DDC network controller hardware, wiring, and software necessary to communicate with the UMC via BACnet MS/TP, with full support all objects, properties and services provided by the UMC BACnet interface.
 - 2. Modbus/RTU: Include the BAS networks, DDC network controller hardware, routers and gateways as required, wiring, and software necessary to communicate with the UMC via Modbus/RTU, with full support for all registers and data types provided by the UMC Modbus interface.

3. BACnet/IP: Include the BAS networks, DDC network controller hardware, wiring, and software necessary to communicate with the UMC via BACnet/IP, with full support for all objects, properties, and services provided by the UMC BACnet interface.
 4. Modbus/TCP: Include the BAS networks, DDC network controller hardware, routers and gateways as required, wiring, and software necessary to communicate with the UMC via Modbus/RTU, with full support for all registers and data types provided by the UMC Modbus interface.
- F. When the final method of interface is unknown at bid time, the cost premium for one method over the other for BAS interface to a given UMC shall be included at the greater cost.
- G. Provide all communication wiring to the UMC.
- H. Provide all power wiring to the UMC unless UMC includes manufacturer power connection from host equipment.
- I. Install gateways or routers necessary to achieve the data connection, whether furnished under this Section or by UMC manufacturer.

3.02 OPERATOR INTERFACE SOFTWARE

A. General Requirements

1. A single integrated software package shall be used as the operator interface program. Systems which require the use of multiple operator interface programs to access all controller point data will not be accepted.
2. The Operator Interface Software shall serve web pages, viewable in any common current web browser, as the primary means of user interface. The web interface shall be native to the system and not an add-on. There shall be no difference between the user interface when viewed from a web browser or from within the operator interface program itself.
3. Operator Interface Software Upgrades which result in the correction of known software deficiencies, "bugs", shall be provided free of charge for each licensed workstation for a period of five years.
4. All inputs, outputs, set points, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, analog point range, span and signal conversion values, etc. and all other parameters, as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software. View/Modify of all points within the system shall be performed by one operator interface software package. Modification of the values of set points or other parameters shall not require the "reloading" of a controller's applications software.
5. The operator workstation software shall provide context-sensitive help menus and instructions for each operation and/or application currently being performed.
6. System database information storage shall comply with one of the following:
 - a. Stored in a comma delimited text based format capable of being importing into user application software for creation of documentation and/or custom reports.
 - b. Stored in an industry standard database format such as Access, Paradox, Interbase, etc. The database shall support third party software queries using industry standard SQL commands for the creation of documentation and/or custom reports.
7. The workstation RAM memory shall be expanded, if necessary, to provide a minimum of 25% free memory when ALL applications are running in their most memory intensive modes.
8. The operation of the control system shall be independent of the operator workstation which shall be used for operator communications only. Systems which rely on the

operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

9. Provide all licensing for all software packages at all required workstations and servers. BAS licensing shall allow unlimited simultaneous users for access to all aspects of the system including system access, controllers, points, programming, database management, user interfaces etc. No restrictions shall be placed on the licensing. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.

B. Alarms

1. Each workstation shall receive and process alarms sent to it by the control system. The alarm management portion of the operator workstation software shall provide the following functions as a minimum:
 - a. Log date and time of alarm occurrence. Print alarm message on selected printer. Multiple alarm messages shall be printed on one sheet of paper to save paper. One message per sheet is not acceptable.
 - b. Generate a 'Pop-Up' window informing an operator that an alarm has been received.
 - c. Allow an operator, with the appropriate security level, to acknowledge, delete or disable an alarm.
 - d. Provide an audit trail log for alarms by recording operator acknowledgment, deleting or disabling of an alarm to a file on the workstation hard drive. Each log entry shall include the name of the operator, the alarm, the action taken on the alarm and a time/date stamp.
 - e. All alarms received at an operator workstation shall be recorded to the hard drive.
 - f. The alarm management software shall allow the operators to view/manage the alarm data archived to hard disk. Selection of a single menu item or tool bar button shall allow the user to acknowledge, disable, delete or print the selected alarm.
2. Alarms shall be generated by the operator workstation for any controller that is 'Off-Line' and is not communicating or that does not have an active control program loaded.
3. Changes made to alarm set points from the Operator Workstation shall directly modify the controller alarm management database. Systems which require permanent alarm set point changes to be made with a program editor shall not be acceptable.
4. Selection of a single menu item or tool bar button shall print any displayed alarm report on the system printer for use as a building management and diagnostics tool.

C. Historical Trend Data Display

1. Provide trending for each system point that allows the user to easily monitor and preserve records of system activity over an extended period of time. Each system point shall be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data may be selected by the operator to be automatically stored on hard disk for future diagnostics and reporting.
2. Trend data shall be accumulated within the field controllers and shall be uploaded to the workstation for display.
3. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 4 points.
4. Selection of a single menu item or tool bar button shall automatically format the trend information into a comma delimited tabular data file which will be directly importable by an off-the-shelf spreadsheet package such as Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.

5. The user shall be able to view trended data on trend tabular report displays. Reports shall display static point data from a remote controller's history trend buffers. A minimum of 4 points may be viewed simultaneously on a single table. Displays shall include a time/date stamp for each sample, column header with name of point/attribute being trended and engineering units for point. Points from multiple controllers shall be capable of being displayed on the same report.
6. Selection of a single menu item or tool bar button shall print any displayed trend data table on the system printer for use as a building management and diagnostics tool.
7. Pre-configure the system to provide 96 samples at 15 minute intervals for all analog points and 24 samples of change in value for all binary points unless otherwise specified in Part 3.
8. Provide formatted trend report displays for each point. Include all trend data and associated parameters.

D. Program Editor

1. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
2. Provide an integrated development environment (IDE) to allow the operator to create/modify controller programs.
3. Programmer IDE shall provide context-sensitive help menus and instructions for each operation and/or application currently being performed, for all programming library functions and for the programming language itself.
4. Selection of a single menu item or tool bar button shall print any displayed program on the system printer or to a text archive file. For source code orientated languages, provide formatted text printouts. For graphical object orientated languages, provide program flow charts of objects including links between objects and parameter values.
5. Definition of operator device characteristics, Digital process control panels, individual points, applications and control sequences shall be performed using instructive prompting software.
6. Libraries of standard application modules such as temperature, humidity and static pressure control which may be used as "building blocks" in defining or creating new control sequences shall be provided. In addition, the user shall have the capability to easily create and archive new modules and control sequences as desired via a word processing type format or visual object configuration type format.
7. Provide a library of standard forms to facilitate definition of point characteristics. Forms shall be self-prompting and incorporate a fill-in-the-blank approach for definition of all parameters. The system shall immediately detect an improper entry and automatically display an error message explaining the nature of the mistake.
8. Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations.
9. Changes shall be automatically recorded and downloaded to the appropriate digital process control panel. The user shall also have the option to selectively download changes as desired.
10. For systems with multiple operator workstations, provide a network based file management utility to keep the workstation databases "synchronized".
 - a. This software shall on a preprogrammed basis update all workstations with the latest revisions of controller configuration and program files from each workstation.
 - b. Systems which rely on a database file-server to store and distribute workstation database files shall not be accepted unless each operator workstation maintains a local copy of all system database information which will automatically be used to

provide operator access to the system in the event of a loss of communications with the file-server.

- c. Under no condition shall the loss or removal of one operator workstation affect the operation of other workstations on the network.
- d. Provide a network, serial or parallel port data connection for the portable operator terminal to update its system database when specifically connected and activated by an operator.

E. Reports

1. Reports shall be generated and directed to either workstation displays, printers or disk. As a minimum, the system shall provide the following reports:
 - a. All points in the network.
 - b. All points in a specific controller.
 - c. A listing of a user defined group of points in the network. There shall be no limit to the number of user defined groups.
 - d. All points currently in alarm.
 - e. All points in hardware override.
 - f. All disabled points.
 - g. All weekly schedules.
 - h. All or selected point attributes, including, but not limited to:
 - 1) Values.
 - 2) Set points.
 - 3) Alarm Limits.
 - 4) Statistics.
 - 5) Run Times.
 - i. All programmed holidays and associated schedules.
 - j. All disabled alarms.
 - k. All active, unacknowledged alarms.
 - l. All active, acknowledged alarms.
 - m. All archived alarms.
 - n. Any and all other controller operating parameters.
2. Reports shall be provided for specific point types, for each logical point group, for user-defined groups or for the entire facility without restriction due to the hardware configuration of the control system or communications network.
3. The system shall allow for the creation of custom report point groups which shall be capable of including points from multiple controllers. Systems limiting point report displays to only a single controller's point database shall not be accepted.
4. The number of custom reports or display groups shall only be limited by the amount of available system memory.
5. Selection of a single menu item or tool bar button shall print any displayed report on the system printer for use as a building management and diagnostics tool.

F. Schedules

1. Provide a spreadsheet-type schedule input form for time-of-day scheduling and override scheduling of building operations. Provide the following spreadsheet types as a minimum:
 - a. Weekly schedules, by system.
 - b. Temporary override schedules, by system.
 - c. Special "Only Active If Today Is a Holiday" schedules, by system.
 - d. Monthly calendars.
 - e. Holiday scheduling system, including the ability to define floating holidays.

2. Weekly schedules shall be provided for each piece of equipment with a specific time use schedule. Each schedule shall include columns for each day of the week as well as holiday and special day columns for alternate scheduling on user-defined days. Equipment scheduling shall be accomplished by simply inserting use and non-use times into appropriate information blocks on the spreadsheet.
3. It shall be possible to define one or more master holiday schedules to allow the operator to define in one location the holidays for all associated schedules. Systems requiring the operator to change holiday definitions on a schedule by schedule basis shall not be accepted.
4. Standard weekly schedules shall be inactive on a holiday. The system shall allow the user to include in a schedule group a schedule which will only be active if today is a holiday.
5. In addition, temporary overrides schedules may be inserted into schedule groups for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.
6. Schedules shall be provided for each system or sub-system in the facility. Each schedule shall include all commandable points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.
7. Monthly calendars for a 24-month period shall be provided which allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard and shall automatically reschedule equipment operation as previously defined on the weekly schedules.
8. Changes to schedules made from the Operator Workstation shall directly modify the controller schedule database. Systems which require permanent schedule changes to be made with a program editor shall not be acceptable.
9. Provide formatted schedule displays for each system. Include all schedule data and associated parameters.
10. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

G. Security

1. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
2. Each user shall have; a user name - 12 characters minimum, a password - 12 characters minimum, and an access level from 0 - 5.
3. Each user may change their password at will.
4. Passwords when entered or edited will not echo the actual characters for display on the monitor.
5. A minimum of six levels of access shall be supported as follows:
 - a. Inactive - Level 0
 - 1) User temporarily disabled - NO system access.
 - b. Guest - Level 1
 - 1) View only.
 - c. Operator - Level 2
 - 1) Modify/Override point values for set points and outputs.
 - 2) View and acknowledge alarms.
 - 3) View and print reports.
 - 4) View and print point history trends.
 - 5) Enter temporary schedules.

- 6) Request extended after-hours operation.
- 7) Change personal password.
- d. Supervisor - Level 3
 - 1) Modify/Override point values for set points, outputs and inputs.
 - 2) Enter weekly schedules.
 - 3) Enter holiday schedules.
 - 4) Set alarm limit set points.
 - 5) Enable/Disable alarms.
 - 6) Assign alarm messages to alarms.
 - 7) Enable/Disable alarm paging for individual alarms.
 - 8) Set point history trend parameters.
 - 9) Reload controller programs.
 - 10) Maintain system database archives including making tape or disk backups.
- e. Programmer - Level 4
 - 1) Create/Modify reports.
 - 2) Create/Modify alarms and alarm messages.
 - 3) Create/Modify display screens.
 - 4) Configure and program controllers.
- f. Administrator - Level 5
 - 1) Create/Modify/Delete users.
 - 2) All available system privileges.
6. Systems which do not provide the specified six programmed access levels in a preprogrammed package shall include pre-configured macro templates to allow a user to quickly select the access level desired without having to manually configure individual security items to match the access standards for the selected level.
7. A minimum of 50 unique users shall be supported.
8. Operators shall be able to perform only those commands available for their respective access level. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.
9. The system shall automatically generate a report of log-on/log-off and system activity. Any action which results in a change in the operation or configuration of the control system shall be recorded, including modification of point values, schedules or history collection parameters and all changes to the alarm management system including the acknowledgment and deletion of alarms.
10. User-definable, automatic log-off timers of from 5 to 60 minutes shall be provided to prevent operators from inadvertently leaving the operator workstation logged on.
11. A default user shall be configurable for automatic logon upon workstation system startup.
12. The BAS Contractor shall provide a fully functional and implemented security system as defined herein.
- H. System Configuration
 1. The system shall be provided complete with all equipment, software and documentation necessary to allow an operator to independently perform ALL system configuration functions.
- I. Development Tools
 1. Graphic generation software shall be provided to allow the user to add, modify or delete system graphic displays.
 2. The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard system components (e.g., refrigeration units, cooling towers, fan system components) and electrical symbols.

3. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
 - a. Define symbols.
 - b. Position and size symbols.
 - c. Define background screens via a graphics drawing utility
 - d. Define connecting lines and curves.
 - e. Locate, orient and size descriptive text using all available system fonts.
 - f. Define and display colors for all elements.
 - g. Establish correlation between symbols or text and associated system points or other displays.
 - h. Import PCX, BMP, WMF and JPG graphic format files.
 - i. Support graphics with a minimum of 64 K colors and a resolution of 800 x 600 pixels.
4. Graphical displays shall be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.
 - a. To accomplish this, the user shall be able to build graphic displays that include point data from multiple direct digital controllers.

J. Dynamic Graphical Displays

1. Color graphic floor plan displays and system flow schematics for each piece of mechanical equipment, including refrigeration units, pumps, cooling towers, control valves, ventilation and air handling units, and as indicated in the point I/O summary of this specification, shall be provided by the BAS Contractor, as specified in Part 3 or as shown on the design drawings, to optimize system performance analysis and speed alarm recognition.
2. Each mechanical system shall display all associated program parameters, i.e. set points, applicable variables, on a tabular or graphical screen with quick link directly to the system flow schematic diagram display. Provide multiple screens as required to display all information in an easy to read and well organized format. Parameters shall be grouped by logical function association.
3. Each mechanical system shall display associated schedule information on the specified formatted display which shall be linked to the system schematic diagram display.
4. Each history trend display for a mechanical system shall be linked to the systems schematic or parameter display screens.
5. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
6. Dynamic temperature values, humidity values, pressure values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
7. Dynamic graphical displays shall support a minimum of 100 live data links per display.
8. Each individual system graphic screen shall have a user definable minimum password level required for user access.
9. Each system graphic screen display shall draw, bind and update all information in less than 10 seconds.

K. Historical Data Graphical Displays

1. Provide a historical data display for each specified history trend that allows the user to view the trended data on a graphical display. Displays shall be actual plots of both static and real-time dynamic point data.
2. A minimum of 4 points may be viewed simultaneously on a single graph, with color selection and line type for each point being user-definable.

3. Displays shall include an 'X' axis indicating elapsed time and a 'Y' axis indicating a range scale in engineering units for each point. The 'Y' axis shall have the ability to be manually or automatically scaled at the user's option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the 'Y' axis. All 'Y' axis data shall be color-coded to match the line color for the corresponding point.
 4. Static graphs shall represent actual point data that has been trended within the field controllers, retrieved and stored on disk. Exact point values may be viewed on a data window by pointing or scrolling to the place of interest along the graph.
 5. Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been pre-defined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis.
 6. The user shall be able to print any graph on the system printer for use as a building management and diagnostics tool in both a tabular text format and as a graphical screen print.
- L. Schedule Displays
1. The system shall allow the user to create custom configured schedule entry/display graphics.

PART 3 EXECUTION

4.01 EXAMINATION

- A. Refer to 23 09 00 Examination
- B. PREPARATION
 1. Refer to 23 09 00 Preparation
- C. INSTALLATION
 1. Refer to 23 09 00 Installation
- D. SITE QUALITY CONTROL
 1. Refer to 23 09 00 Site Quality Control
- E. SYSTEM STARTUP
 1. Refer to 23 09 00 System Startup
 2. ADJUSTING
 3. Refer to 23 09 00 Adjusting
- F. CLEANING
 1. Refer to 23 09 00 Cleaning
- G. CLOSEOUT ACTIVITIES
 1. Refer to 23 09 00 Closeout Activities
- H. PROTECTION
 1. Refer to 23 09 00 Protection
- I. MAINTENANCE

1. Refer to 23 09 00 Maintenance

SECTION 230966

ETHERNET NETWORK FOR INTEGRATED AUTOMATION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. BAS Structured Cabling Infrastructure\
 - 2. BAS Network Equipment
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including the General Conditions and Supplementary Conditions apply to this section.
 - 2. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
 - 3. Division 01 Specification Section
 - 4. Division 27 Specification Section
 - 5. HVAC Control Sections:
 - a. Section 23 09 00 – Common Work Results for HVAC Control
 - 1) Requirements common to all HVAC Control Sections
 - b. Section 23 09 13 – Instrumentation and Control Devices for HVAC
 - 1) Input devices, output devices, control valves, control dampers
 - c. Section 23 09 23 – Direct-Digital Control System for HVAC
 - 1) DDC networks, DDC controllers, DDC software
- C. System Description:
 - 1. Provide and install a complete active TCP/IP Ethernet based network to support the BAS. Contractor shall install Ethernet switches, routers, as required to support BAS as defined in the contract documents.
 - 2. Provide and install a complete structured cabling system (SCS) to support BAS network. The backbone cabling shall support data communications systems between the (update per project) All horizontal distribution cabling to each workstation location shall be included as part of the project. The principal bid for this project shall be based on a Category 5E structured cabling system as manufactured by Hubbell / Hitachi. All cabling shall be installed with conduit unless within a vertical riser.
 - 3. Provide and install a complete active TCP/IP Ethernet based network to support the BAS. Contractor shall install three Ethernet switches and provide appropriate configuration and programming to support aggregated links between switches, appropriate IP addressing for distributed computers, and configuration for a complete and operable IP network for all computers/switches as shown on the Drawings. Provide a single point connection through the use of a router or secondary network interface card in the BAS server for connection to the building network and external access.
- D. Contractor qualifications / requirements:
 - 1. The contractor selected for this project shall be certified by the SCS manufacturer, adhere to the design engineering, installation and testing procedures and utilize the authorized manufacturer components in completing this project.

2. The contractor shall have a BICSI certified RCDD on staff and readily available for this project. Copy of BICSI certificate or stamp shall be provided. Lead installer shall have a minimum of 5-years of installation work experience running projects.
3. The contractor shall be experienced in all aspects of the work required to complete this project and shall be required to demonstrate direct experience on recently installed systems of similar size and type.
4. The contractor shall carefully examine the contract documents and make arrangements to visit the site, and thoroughly become familiar with the building standards and local conditions relating to the work. Failure to do so will not relieve the contractor of the obligations of the contract.
5. The contractor shall own and maintain equipment and tools required for the installation and testing of Category 5E metallic structured cabling systems. The contractor shall also employ personnel who are adequately trained in the uses of required tools and equipment.
6. These documents detail the components and installation guidelines that shall be included for the project. These documents contain work that is the responsibility of multiple contractors i.e. Communication contractor, electrical contractor, general contractor etc. It is not the intent of these documents to dictate which contractor is responsible for each task; the general contractor/construction manager shall delegate the work to the appropriate sub-contractors.
7. Contractor shall provide a proposal for all labor and material to install a complete structured cabling system, including but not limited to all required cabling, racks, patch panels, support hardware, cross connects, patch cords, raceways, telecommunications outlets, etc.

1.02 ADMINISTRATIVE REQUIREMENTS

- A. Refer to 23 09 00 Administrative Requirements for requirements applicable to This Section, in addition to the items of This Article.
- B. Coordination:
 1. Owner's Information Technology Department: coordinate interfaces between network(s) provided under This Section and Owner Networks, with Owner's IT/IS department, for compatibility with the Owner's networks and other systems.

1.03 REFERENCES

- A. Abbreviations and Acronyms
 1. Authority Having Jurisdiction
 2. American National Standards Institute
 3. American Wire Gauge
 4. Building Automation System
 5. Commissioning Authority
 6. Data Center
 7. Direct-Digital Controls
 8. Electrical Contractor
 9. Equipment Room
 10. Electronic Industries Alliance
 11. Engineer Of Record
 12. F/UTP:Foiled/Unshielded Twisted Pair Cable
 13. General Contractor

14. Multi Mode Fiber
15. Nationally Recognized Testing Laboratory
16. Operator Workstation Definitions
17. Structured Cabling System
18. Single Mode Fiber
19. Shielded Twisted Pair Cable
20. Telecommunications Contractor
21. Telecommunication Industry Association
22. Telecommunications Grounding Busbar
23. TMGB:Telecommunications Main Grounding Busbar
24. Telecommunications Room
25. Unless Noted Otherwise
26. UTP – UNSHIELDED TWISTED PAIR CABLE

B. Reference Standards

- a. NFPA 70 - National Electrical Code.
- b. TIA-606 - Administration Standard for Telecommunications Infrastructure.
- c. TIA-607 - Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
2. Work shall comply with the indicated reference standards and codes, or the relevant United States Standard, or the applicable standards and codes of the Authority Having Jurisdiction, whichever is the most stringent.
 - a. ANSI/TIA/EIA-568-C.0, .1, .2 and .3
 - b. NFPA 70 "National Electric Code"
 - c. Chicago electric code
 - d. Local and state building codes.
 - e. Authority having jurisdiction.
 - f. UI 910 "UL standard for safety test for flame-propagation and smoke density values for electrical and optical-fiber cables used in spaces transporting environmental air." provide products that are UL listed and labeled for such use.
 - g. American National Standards Institute / Telecommunications Industry Association / Electronic Industries Alliance - ANSI/TIA/EIA including associated addenda.
 - 1) ANSI/TIA-568– commercial building telecommunications cabling standard.
 - 2) ANSI/TIA-606 – administration standard for telecommunications infrastructure.
 - 3) ANSI/TIA-607 – generic telecommunications bonding and grounding (earthing) for customer premises.
 - 4) ANSI/TIA-1152 – requirements for field test instruments and measurements for balanced twisted-pair cabling
 - 5) ANSI/TIA 568 – standard for installing commercial building telecommunications cabling.
 - h. National Electrical Manufacturers Association (NEMA).
 - i. American Society For Testing Materials (ASTM).
 - j. Institute Of Electrical And Electronic Engineers (IEEE).

1.04 SUBMITTALS

- A. Refer to 23 09 00 Submittals for requirements applicable to This Section
- B. Required Submittals:
 1. Product Data: Each product
 2. Riser Diagrams: Complete Ethernet network under This Section

3. Panel Construction Diagrams: Each network equipment rack or panel
 4. Bill of Materials: All products
 5. Wiring Diagrams: Each unique termination, and all products
 6. Floor Plan Drawings: All products and pathways
- C. Technology Submittals:
1. Certain technology products under This Section require final product submittals no more than three months prior to delivery to site
 2. Provide initial product submittals for all items as part of complete project submittal package
 3. Resubmit Product Data for the following technology products no more than three months prior to delivery to site, highlighting each changed specification or noted as "no changes"
 - a. BAS Network Equipment

1.05 CLOSEOUT SUBMITTALS

- A. Refer to 23 09 00 Closeout Submittals for requirements applicable to This Section, in addition to the requirements of This Article
- B. File all Closeout Submittals, from this and all related Sections, electronically within the BAS for web browser-based on-line access by any BAS user
- C. Required Closeout Submittals:
1. Manufacturer's Operation and Maintenance Manuals: Each product
 2. Custom Operation and Maintenance Manual for BAS System, including the following documentation:
 - a. Table of Contents.
 - b. System Architecture Diagrams.
 - c. General description and cut sheets for all components.
 - d. Complete trouble-shooting procedures and guidelines.
 - e. Complete operating instructions for all systems and software.
 - f. Maintenance Instructions: Document all maintenance and repair / replacement procedures. Provide ordering
 - g. Appendix A: Sample printouts of all; Reports, Group Listings and Alarm Messages.
 - h. Appendix B: Printed listing of all BAS Ethernet network equipment. Include Name, ID Number, Description, Where Located, Manufacturer and Model Number, IP Address / Mask / Gateway, and Current Firmware Version
 3. System Warranty Documentation: According to 23 09 00 Warranty requirements
 4. Product Warranty Documentation: Each product, as provided by manufacturer
 5. Record Documentation: According to 23 09 00 Record Documentation
 6. Software Applications on removable media (USB, CD/DVD): Each application.

1.06 WARRANTY

- A. Warrant the Products and Workmanship under This Section as a complete system along with the Products and Workmanship under other related Sections, according to 23 09 00 Warranty - Vendor Warranty.

PART 2 PRODUCTS

2.01 STRUCTURED CABLING INFRASTRUCTURE AND DIGITAL NETWORK

- A. Grounding
 - 1. Ground to nearest ground bar
- B. Raceway systems
 - 1. All cabling shall be in conduit unless in existing riser pathway.
- C. Telecommunication boxes
 - 1. Wall boxes shall be 4 11/16" x 4 11/16" x double gang boxes (11B) deep junction box with a single gang plaster ring opening unless otherwise noted.
 - 2. Wall mounted racks shall include:
 - a. 36" x 25" x 20" h x w x d with standard EIA 19" mounting holes pre-drilled and tapped.
 - b. Standard 19" EIA mounting rails.
 - c. Perforated front and rear removable locking door.
 - 3. Horizontal wire managers shall:
 - a. Mount in a standard 19" wide rack.
 - 4. Part number # NP2K624 cable management kit (Neat Patch)

2.02 TWISTED PAIR CABLE

- A. Category 5E UTP (CAT 5E):
 - 1. Category 5E 4-pair UTP cables shall consist of 4-pair, 24 gauge, UTP, and shall terminate on 8 pin modular jacks at each outlet.
 - 2. All cable jacket material shall conform to article 800 NEC for use as a plenum or non-plenum cable. Cables shall be UL listed type CMP (plenum) or CM/CMR (non-plenum), as appropriate.
 - 3. All category 5E 4-pair UTP cables shall meet or exceed the requirements of ANSI/TIA/EIA-568-c.2 and be part of a NRTL LAN certification and follow-up program.
- B. Part number # 39419-8 (Hitachi)

2.03 CATEGORY 5E UTP (CAT 5E) RISER CABLING:

- 1. Category 5E 4-pair UTP cables shall consist of 4-pair, 24 gauge, UTP, and shall terminate on 8 pin modular jacks at each outlet.
- 2. All cable jacket material shall conform to article 800 NEC for use as a plenum or non-plenum cable. Cables shall be UL listed type CMP (plenum) or CM/CMR (non-plenum), as appropriate.
- 3. All category 5E 4-pair UTP cables shall meet or exceed the requirements of ANSI/TIA/EIA-568-c.2 and be part of a NRTL LAN certification and follow-up program.

2.04 PART NUMBER # 39419-8 (HITACHI)

2.05 OPTICAL FIBER CABLES

- 1. Fiber optic cabling shall all bear OFNR, OFNP and/or appropriate markings for the environment in which they are to be installed.
 - a. 50 micron multimode fiber optic cable:
 - 1) Number of fibers: as noted on drawings

- 2) Jacket color: aqua
- 3) Core diameter: $50\ \mu\text{m} \pm 3\ \mu\text{m}$
- 4) Cladding diameter: $125\ \mu\text{m} \pm 2\ \mu\text{m}$
- 5) Buffering: 900 nm
- 6) Maximum attenuation at 850 nm: 3.5 dB/Km
- 7) Maximum attenuation at 1300 nm: 1.0 dB/Km
- 8) Minimum bandwidth at 850 nm OFL: 1500 MHz
- 9) Laser bandwidth at 850 nm: 2000 MHz
- 10) Minimum bandwidth at 1300 nm: 500 MHz
- 11) Cable minimum bend radius during installation: 15 times cable diameter
- 12) Cable minimum bend radius after installation: 10 times cable diameter or 0.75", whichever is greater
- 13) Operating temperature range: 40° to 158°F.
- 14) Storage temperature range: 40° to 158°.

B. Patch panels

1. Copper patch panels shall be
 - a. High density such that 24 ports occupy 1 rack space
 - b. Patch panel cable terminations shall be 110 type insulation displacement contact printed circuit board unless noted otherwise.
 - c. Have a cable management bar to ensure proper bend radius and strain relief
 - d. Comply with ANSI/TIA/EIA-606-a labeling standards.

PART NUMBER # P5E24UW (HUBBELL)

3.01 FIBER PATCH PANELS SHALL BE:

1. Mount in standard 19" rack EIA/TIA rails
2. Front loading panels
3. Comply with ANSI/TIA/EIA-606-A labeling standards
4. 1 RMU shelf must accept a minimum of 48 LC connectors.

B. Information outlets

1. Jacks shall:
 - a. Meet or exceed all transmission requirements for the specific category rating e.g. CAT 5E, CAT 6 etc.
 - b. Wiring termination sequence for 568-b wiring scheme
 - c. Meet the electrical, mechanical and clearance specifications in FCC rules and regulations, part 68, subpart f.
 - d. UL listed and CSA certified

PART NUMBER # HXJ5EGN (HUBBELL)

4.01 FACE PLATES SHALL:

- a. Possess designation windows to facilitate labeling and conform with ANSI/TIA/EIA - 606a labeling standards
- b. Be available in a variety of configurations and port capacities to satisfy the design requirements.
- c. Be available in a variety of colors to match the design.

- d. Be available in flush and surface mount to accommodate wall boxes and furniture raceways.
- e. Be UL listed and CSA certified

PART NUMBER # IFP14W (HUBBELL)

5.01 MULTIMODE

- 1. All multimode connector shall be LC and have the following features:
 - a. Anaerobic epoxy cured, cleaned and polished termination. Mechanical splice type "quick crimp" or "cleave and leave" type connections are not permitted.
 - b. insertion loss 0.2 dB typical
 - c. Reflection < -40 dB
 - d. Material:
 - 1) Ferrule: phosphor bronze zirconia
 - 2) Housing: thermoplastic

B. Patch Cords (see Neat Patch under Telecommunications Boxes)

PART 3 EXECUTION

6.01 INSTALLATION

A. Grounding

- 1. Contractor shall ground both swing racks from nearest Hogan ground with (1) #6 ground wire double lugged.

B. Conduit systems

- 1. Exact conduit lengths shall be coordinated so as to not exceed cable length limitations as directed by This Specification and Division 27.
- 2. All conduit raceway capacities are based on unshielded 24 gauge 4-pair twisted pair cabling. The exact quantity of cables per outlet location shall be confirmed and communications drawings so as to not exceed 38% fill of raceway. The exact quantity and type of cable(s) per wall, floor or furniture communications outlets shall be determined by the communications drawings. Use only symbols shown on communications drawings for quantities to be bid and installed as part of this project. Minimum conduit sizing for all communications outlets shall be 3/4 inch unless noted otherwise.

	NUMBER OF CABLES	CONDUIT SYSTEMS	WIREWAYS AND SURFACE METAL SYSTEMS	OPEN CABLE TRAYS
	1	53%	N/A	N/A
	2	31%	20%	N/A
	>2	38%	20%	25%

C. Telecommunication boxes

- 1. Wall boxes shall be 4-11/16" x 4-11/16" x double gang boxes (11 B type)" deep junction box with a single gang plaster ring opening unless otherwise noted contractor shall coordinate with the architecture and electrical plans to coordinate with cable quantity and type.

D. Twisted pair installation

1. Includes all categories
 - a. All cable runs between the termination hardware and the telecommunications outlet shall be continuous without any splices.
 - b. The minimum bend radius, under no-load conditions, for 4-pair UTP cables shall be 1 inch or 4 times the cable diameter.
- E. Labeling
 1. All labeling of SCS components (cable, patch panels, etc.), pathway elements, grounding, racks, cabinets, spaces, etc. Shall be in accordance with ANSI/TIA/ 606 and associated addenda and ANSI/TIA-942 as applicable.
 2. Contractor shall label all telecommunications cables, faceplates, patch panels and termination hardware with permanent machine typed labels in accordance with telecommunication drawings.
 3. Cable labels shall be placed 12 to 18 inches from the point of termination.
 4. Faceplate labels shall be ¼ inch text size placed under the transparent faceplate label protector.
- F. Twisted pair cable testing
 1. Testing of all copper wiring shall be performed prior to system cutover. 100 percent of the horizontal, riser and inter-cabinet wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of ac voltage.
 2. In addition to the parameters listed above, all category 5e twisted-pair cabling shall also include the following permanent link tests: return loss, PSNEXT loss (measured from both the local end and the far end), ACRF (measured from both the local end and the far end) and PSACRF (measured from both the local end and the far end).
 3. The contractor shall notify the client and EOR in writing a minimum of 72 hours prior to the start of testing and provide a complete testing schedule to allow for witnessing of testing.
 4. Contractor shall provide current certificate(s) of calibration for all test equipment to be used for this project. Certificates must indicate serial numbers and test dates and that the test set(s) has been calibrated by the manufacturer. No tests shall be performed with test equipment that has not been calibrated within 6 months prior to field testing.
 5. Complete end to end test results shall be submitted to the client and eor in both electronic format (CD or DVD) and hard copy. No hand written test results will be accepted. If special software or license is required to review test data electronically, contractor shall provide one copy of software and appropriate license with each set of test data.
 6. Acceptable copper test sets:
 - a. Agilent
 - b. Fluke
 - c. Engineer approved equal
 - 1) Contractor shall provide calculations indicating the maximum loss budget for each fiber using the following formula.
 - 2) (allowable cable loss per km) x (km of fiber in link) + (mfr published connector loss) x (number of connectors) = maximum allowable loss
 - 3) The contractor shall provide loss budgets to EOR for review prior to testing.
 - 4) The contractor shall notify the client and EOR in writing a minimum of 72 hours prior to the start of testing and provide a complete testing schedule to allow for witnessing of testing.
 - 5) The contractor shall submit calibration certificate(s) indicating that the test set(s) has been calibrated by the manufacturer. No test shall be performed with a test set that has not been calibrated within 6 months prior to testing.

- d. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no cost to the client.
- e. Complete end to end test results shall be submitted to the client and eor in both electronic format (CD or DVD) and hard copy. No hand written test results will be accepted. If special software or license is required to review test data electronically, contractor shall provide one copy of software and appropriate license with each set of test data.
- f. Acceptable test sets:
 - 1) Alcoa fujikura
 - 2) Corning cable systems
 - 3) Fluke
 - 4) Noyes
 - 5) Tektronix
 - 6) Engineer approved equal

SECTION 232113
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Chilled water piping, above grade.
- D. Equipment drains and overflows.
- E. Pipe hangers and supports.
- F. Unions, flanges, and dielectric connections.
- G. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
- H. Flow controls.

1.02 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 083100 - Access Doors and Panels.
- C. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
- D. Section 230523 - General-Duty Valves for HVAC Piping.
- E. Section 230553 - Identification for HVAC Piping and Equipment.
- F. Section 230719 - HVAC Piping Insulation.
- G. Section 232114 - Hydronic Specialties.
- H. Section 232500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- B. {RSTEMP#372}ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers{CH#84459}.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- E. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings.
- F. ASME B31.9 - Building Services Piping.
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- H. {RSTEMP#434}ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service{CH#84056}.
- I. ASTM B32 - Standard Specification for Solder Metal.
- J. {RSTEMP#591}ASTM B88 - Standard Specification for Seamless Copper Water Tube{CH#84064}.
- K. {RSTEMP#592}ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric){CH#84067}.
- L. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- M. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- N. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- O. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe.
- P. AWWA C606 - Grooved and Shouldered Joints.
- Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
 - b. Use rigid joints unless otherwise indicated.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 - 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 3. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
 - 4. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.
 - 5. In heating water or chilled water systems, butterfly valves may be used interchangeably with gate and globe valves.
 - 6. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.
 - 7. For throttling service, use plug cocks. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 HEATING WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:

1. Welded Joints: {RS#434}, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
 2. Threaded Joints: {RS#372}, malleable iron fittings.
- B. Copper Tube: {RS#591} ({RS#592}), Type K (A), drawn, using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.51, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Apollo Valves: www.apollovalves.com/#sle.
 - 2) FNW; Copper Press: www.fnw.com/#sle.

2.03 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
1. Welded Joints: {RS#434}, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
 2. Threaded Joints: {RS#372}, malleable iron fittings.
 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: {RS#591} ({RS#592}), Type K (A), hard drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.51, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Apollo Valves: www.apollovalves.com/#sle.
 - 2) FNW; Copper Press: www.fnw.com/#sle.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
1. Threaded Joints: Galvanized cast iron, or {RS#372} malleable iron fittings.
- B. Copper Tube: {RS#591} ({RS#592}), Type K (A), drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.05 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

2.06 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe of 2 Inches and Less:
- B. Flanges for Pipe 2 Inches and Greater:
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 1. Dimensions and Testing: In accordance with AWWA C606.
 2. Mechanical Couplings: Comply with ASTM F1476.
 3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 4. When pipe is field grooved, provide coupling manufacturer's grooving tools.
- D. Dielectric Connections:
 1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600-volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
 2. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.
 3. Unions:
 - a. 1/2 to 1 Inches: Brass solder to galvanized FPT.
 - b. 1/2 to 2 Inches: Brass solder to galvanized FPT.
 - c. 1/2 to 1 Inches: Brass to galvanized FPT or FIP (Female Iron Pipe).
 - d. 3/4 to 1/2 Inch Reducer: Brass solder to galvanized FPT.
 - e. Service: 250 psi, minus 20 to 180 deg F.

2.07 BALL VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
- B. Over 2 Inches:
 - 1. Ductile iron body, chrome plated stainless steel ball, seat and stuffing box seals, flanged ends, rated to 800 psi.

2.08 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, lug ends, extended neck.
- C. Disc: Construct of stainless steel.
- D. Operator: 10 position lever handle.

2.09 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
- B. Up To and Including 2 Inches:
 - 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.
- C. Over 2 Inches:
 - 1. Iron body, bronze trim, stainless steel, bronze, or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.10 FLOW CONTROLS

- A. Manufacturers:
 - 1. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 - 2. Griswold Controls: www.griswoldcontrols.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. See Section 232500 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water piping and chilled water piping to ASME B31.9 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interference with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors.
- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- H. Slope piping and arrange to drain at low points.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 230516.
- J. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
- K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 230719.

- L. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083100 .
- M. Use eccentric reducers to maintain top of pipe level.
- N. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- O. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

A. Hanger Spacing for Copper Tubing.

- 1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
- 2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
- 3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- 4. 2-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- 5. 3 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- 6. 4 Inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- 7. 6 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- 8. 8 Inches: Maximum span, 16 feet; minimum rod size, 5/8 inch.

B. Hanger Spacing for Steel Piping.

- 1. 1/2 Inch, 3/4 Inch, and 1 Inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
- 2. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
- 3. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- 4. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- 5. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
- 6. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
- 7. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- 8. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
- 9. 8 Inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.

SECTION 232114
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air vents.
- B. Strainers.
- C. Suction diffusers.
- D. Pump connectors.
- E. Pressure-temperature test plugs.
- F. Balancing valves.
- G. Relief valves.
- H. Pressure reducing valves.

1.02 RELATED REQUIREMENTS

- A. Section 232113 - Hydronic Piping.
- B. Section 232500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
- C. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B. Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Air Vent:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
 - 2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.
- D. Maximum Fluid Pressure: 150 psi.
- E. Maximum Fluid Temperature: 250 degrees F.

2.02 STRAINERS

- A. Manufacturers:
 - 1. American Wheatley, a company of Global Flow Products, LLC: www.wheatleyhvac.com/#sle.
 - 2. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 3. Flexicraft Industries: www.flexicraft.com/#sle.
- B. Size 2 inch and Under:
 - 1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.
 - 2. Body Material by Fluid Service:
 - a. Cast Iron or Brass:
 - 1) Steam: Up to 250 psi at 450 degrees F.
 - 2) Liquids: Up to 400 psi at 150 degrees F.
- C. Size 2-1/2 inch to 4 inch:
 - 1. Provide flanged or grooved iron body for up to 175 psi working pressure, up to 250 degrees F working temperature, Y-pattern strainer with 1/16 inch or 3/64 inch stainless steel perforated screen.

2. Body Material by Fluid Service:
 - a. Cast Iron:
 - 1) Steam: Up to 125 psi at 350 degrees F.
 - 2) Liquids: Up to 200 psi at 150 degrees F.
- D. Size 5 inch and Larger:
 1. Provide flanged or grooved iron body for up to 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.
- E. Basket-Type, Size _____ inch for Liquid Service:
 1. Flanged carbon steel body with 1/8 inch stainless steel perforated basket screen, bottom drain and capped air vent.
 2. Fluid Service: Up to 285 psi at 100 degrees F.
- F. Basket-Type, Size 2 to 24 inch for Steam and WOG Service:
 1. Flanged cast iron body with 1/8 inch stainless steel perforated basket screen, and bottom drain.
 2. Fluid Service:
 - a. Steam: Up to 125 psi at 350 degrees F.
 - b. Liquids: Up to 150 psi at 150 degrees F.
- G. Accessories: Provide air vent, hanging tag, outlet ball valve, and PT test plug extension.

2.03 SUCTION DIFFUSERS

- A. Manufacturers:
 1. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 2. Anvil International; _____: www.anvilintl.com/#sle.
 3. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 4. Grinnell Products; _____: www.grinnell.com/#sle.
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- C. Class 125:
 1. Horizontally or vertically mounted angle-pattern fitting with integral-cast vanes, fine particle mesh screen and magnetic drain plugs for particle removal without disassembly.
 2. Maximum Operating Service: 175 psi and 300 degrees F.
 3. Sizes, Material, and Connection:
 - a. 2 inch and Smaller: Cast iron body, threaded.
 - b. 2-1/2 to 12 inch: Ductile iron body, flanged.

2.04 PUMP CONNECTORS

- A. Manufacturers:
 1. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 2. Anvil International; AnviFlex: www.anvilintl.com/#sle.
 3. The Metraflex Company; Vane Flex: www.metraflex.com/#sle.

- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 - 1. Maximum Operating Service: 150 psi at 120 degrees F.
 - 2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: _____ inch.
 - b. Lateral Movement: _____ inch.
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 - 3. End Connections: Same as specified for pipe jointing.
 - 4. Provide pump connector with integral vanes to reduce turbulent flow.
 - 5. Provide necessary accessories including, but not limited to, swivel joints.

2.05 PRESSURE-TEMPERATURE TEST PLUGS

- A. Manufacturers:
 - 1. FNW; _____: www.fnw.com/#sle.
 - 2. Peterson Equipment Company Inc; _____: www.petesplug.com/#sle.
 - 3. Sisco Manufacturing Company Inc; _____: www.siscomfg.com/#sle.
- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- C. Application: Use extended length plugs to clear insulated piping.

2.06 BALANCING VALVES

- A. Manufacturers:
 - 1. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - 3. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Size 2 inch and Smaller:
 - 1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and female sweat, NPT threaded, press, or soldered connections.
 - 2. Metal construction materials consist of bronze, brass, or _____.
 - 3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or _____.
 - 4. Maximum Service Operation: 300 psi at 250 degrees F.
- C. Size 2-1/2 inch and Larger:
 - 1. Provide ball, globe, or butterfly style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged, grooved, or weld-end connections.
 - 2. Valve body construction materials consist of cast iron, carbon steel, ductile iron, or _____.
 - 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin, or _____.
 - 4. Maximum Service Operation: 175 psi at 250 degrees F.

2.07 RELIEF VALVES

- A. Manufacturers:
 - 1. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 - 2. Apollo Valves; _____: www.apollovalves.com/#sle.
 - 3. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.
- C. Steam Relief at Maximum Vessel Pressure: 30 psi.

2.08 PRESSURE REDUCING VALVES

- A. Manufacturers:
 - 1. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 - 2. Apollo Valves; _____: www.apollovalves.com/#sle.
 - 3. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - 4. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - 5. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 232113.
- C. Materials of Construction:
 - 1. Valve Body: Constructed of bronze, cast iron, brass, iron, or _____.
 - 2. Internal Components: Construct of stainless steel, brass, or _____ and engineered plastics, composition material, or _____.
- D. Connections:
 - 1. NPT threaded: 1/2 inch or 3/4inch.
 - 2. Soldered: 1/2 inch.
- E. Provide integral check valve and strainer.
- F. Maximum Inlet Pressure: 400 psi.
- G. Maximum Fluid Temperature: 180 degrees F.
- H. Adjustable Pressure Range: From 10 to 45 psi, set to 25 psi.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

- E. Provide valved drain and hose connection on strainer blowdown connection.
- F. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- G. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- H. Support pump fittings with floor-mounted pipe and flange supports.
- I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- J. Pipe relief valve outlet to nearest floor drain.
- K. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.

SECTION 232123
HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line pumps.

1.02 RELATED REQUIREMENTS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment.
- B. Section 230716 - HVAC Equipment Insulation.
- C. Section 230719 - HVAC Piping Insulation.
- D. Section 230923 - Direct-Digital Control System for HVAC.
- E. Section 230934 - Variable-Frequency Motor Controllers for HVAC.
- F. Section 232113 - Hydronic Piping.
- G. Section 232114 - Hydronic Specialties.
- H. Section 253500 - Integrated Automation Instrumentation and Terminal Devices for HVAC.

1.03 REFERENCE STANDARDS

- A. UL 778 - Standard for Motor-Operated Water Pumps.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Armstrong Fluid Technology, Inc: www.armstrongfluidtechnology.com/#sle.
- B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com/#sle.
- C. Grundfos Pumps Corporation: www.grundfos.com/#sle.

2.02 GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Electrical Requirements:
 - 1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
 - 2. Variable Frequency Drives (VFDs): Provide in accordance with Section 230934, except for integral-VFDs.
 - 3. Enclosures: Provide unspecified product(s) required to fit motor:

2.03 IN-LINE PUMPS

- A. Casing: Cast iron with seal flush connection, threaded suction, and discharge ports with gauge port and drain plug.
- B. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- C. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- D. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 250 degrees F maximum continuous duty temperature.
- E. Electrical:
 - 1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 230513.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Lubricate pumps before start-up.
- D. Controls: Interface each pump starter or VFD with HVAC controller; see Section 230923.
- E. Controls Human-Machine Interface (HMI): HVAC operator terminal; see Section 253500.

SECTION 232213

STEAM AND CONDENSATE HEATING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Steel Pipe and Fittings.
- B. Joining Materials.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 230523 - General-Duty Valves for HVAC Piping.
- B. Section 230553 - Identification for HVAC Piping and Equipment.
- C. Section 230719 - HVAC Piping Insulation.
- D. Section 232214 - Steam and Condensate Heating Specialties.
- E. Section 232500 - HVAC Water Treatment: Pipe cleaning.

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 - 1. LP Steam Piping: .
 - 2. Condensate Piping: at 250 deg F (121 deg C).
 - 3. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
 - 4. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
 - 2. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.

3. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Accept valves on site in shipping containers with labelling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, plain ends, welded and seamless, Grade B, and Schedule as indicated in piping applications articles.
- B. Malleable-Iron Threaded Fittings: {RS#372}; Classes 150 and 300 as indicated in piping applications articles.
- C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in piping applications articles.
- D. Wrought-Steel Fittings: {RS#434}, wall thickness to match adjoining pipe.
- E. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 1. Material Group: 1.1.
 2. End Connections: Butt welding.
 3. Facings: Raised face.
- F. Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.02 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.11, carbon steel, unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 EXECUTION

3.01 APPLICATION

A. Ancillary Piping

1. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
2. Vacuum-Breaker Piping: Outlet, same as service where installed.

B. Valves

1. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
2. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
3. All valves and specialties associated with clean steam and clean steam condensate shall be constructed of passivized 316 stainless steel.

3.02 INSTALLATION

A. Piping

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Install piping to allow application of insulation.
9. Select system components with pressure rating equal to or greater than system operating pressure.
10. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
11. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
12. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
13. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.
14. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
15. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.
16. Install valves according to Division 20 Section 200523 "General-Duty Valves for Piping."

17. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
 18. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
 19. Install shutoff valve immediately upstream of each dielectric fitting.
 20. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Install strainers on their sides in the horizontal plane to prevent the collection and carry-over of condensate.
 21. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
 - a. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet (90 m) .
 - b. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.
 22. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 20 Section 200500 "Common Work Results for Mechanical."
 23. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeves specified in Division 20 Section 200500 "Common Work Results for Mechanical."
 24. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 20 Section 200500 "Common Work Results for Mechanical."
- B. Steam and Condensate Piping Specialties
1. Comply with requirements in Division 23 Section 232216 "Steam and Condensate Piping Specialties" for installation requirements for strainers, flash tanks, special-duty valves, steam traps, thermostatic air vents and vacuum breakers, and steam and condensate meters.

3.03 FIELD QUALITY CONTROL

- A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping," and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush system with clean water. Clean strainers.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

E. Prepare test and inspection reports.

3.04 HANGERS AND SUPPORTS

- A. Comply with requirements in Division 20 Section 200529 "Hangers and Supports" for installation of hangers and supports. Comply with requirements below for maximum spacing.
- B. Seismic restraints are specified in Division 20 Section 200548 "Vibration and Seismic Controls."
- C. Install the following pipe attachments:
 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 4. Spring hangers to support vertical runs.
- D. Install hangers for steel steam supply piping with the following maximum spacing:
 1. NPS 3/4: Maximum span, 9 feet.
 2. NPS 1: Maximum span, 9 feet.
 3. NPS 1-1/2: Maximum span, 12 feet.
 4. NPS 2: Maximum span, 13 feet.
 5. NPS 2-1/2: Maximum span, 14 feet.
 6. NPS 3 and Larger: Maximum span, 15 feet.
- E. Install hangers for steel steam condensate piping with the following maximum spacing:
 1. NPS 3/4: Maximum span, 7 feet.
 2. NPS 1: Maximum span, 7 feet.
 3. NPS 1-1/2: Maximum span, 9 feet.
 4. NPS 2: Maximum span, 10 feet.
 5. NPS 2-1/2: Maximum span, 11 feet.
 6. NPS 3 and Larger: Maximum span, 12 feet.
- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

SECTION 232216

STEAM AND STEAM CONDENSATE PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Valves.
- B. Strainers.
- C. Flash Tanks.
- D. Safety Valves.
- E. Pressure-Reducing Valves.
- F. Steam Traps.
- G. Thermostatic Air Vents and Vacuum Breakers.
- H. Flexible Connectors.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment: Pump motors.
- B. Section 230716 - HVAC Equipment Insulation.
- C. Section 230719 - HVAC Piping Insulation.
- D. Section 232213 - Steam and Condensate Heating Piping.

1.04 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 - 1. LP Steam Piping: .
 - 2. Condensate Piping: at 250 deg F (121 deg C).
 - 3. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
 - 4. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

5. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.05 SUBMITTALS

A. Action Submittals

1. Product Data:
 - a. Provide for manufactured products and assemblies required for this project.
 - b. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - c. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
 - d. Include electrical characteristics and connection requirements.
2. Manufacturer's Installation Instructions: Indicate application, selection, and hookup configuration. Include pipe and accessory elevations.
 - a. Include installation instructions, servicing requirements, and recommended spare parts lists.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose indicated.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 20 Section 200523 "General Duty Valves for Piping."

2.02 STRAINERS

- A. Manufacturers:
 1. Armstrong International.
 2. Anvil International.
 3. Keckley Co.
 4. Metraflex Co.
 5. Mueller Steam Specialty Co.

6. Spirax-Sarco.
 7. Watts.
 8. Yarway.
- B. Y-Pattern Strainers:
1. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
 4. Tapped blowoff plug.
 5. CWP Rating: 250-psig working steam pressure.
- C. Basket Strainers:
1. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
 4. CWP Rating: 250-psig working steam pressure.

2.03 FLASH TANKS

- A. Manufacturers:
1. Cemline.
 2. Spirax-Sarco.
 3. Wessels.
- B. Shop or factory fabricated of welded steel according to {RS#396}, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.04 SAFETY VALVES

- A. Bronze Safety Valves: ASME labeled.
1. Manufacturers:
 - a. Armstrong International.
 - b. Kunkle Valve.
 - c. Spirax Sarco.
 - d. Watts.
 2. Disc Material: Forged copper alloy.
 3. End Connections: Threaded inlet and outlet.
 4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
 5. Pressure Class: 250.
 6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
 7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
- B. Cast-Iron Safety Valves: ASME labeled.
1. Manufacturers:

- a. Armstrong International.
 - b. Kunkle Valve.
 - c. Spirax Sarco.
 - d. Watts.
2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.05 PRESSURE-REDUCING VALVES

- A. Manufacturers:
 1. Armstrong International.
 2. Hoffman Specialty.
 3. Leslie Controls.
 4. Spence Engineering Company.
 5. Spirax Sarco.
- B. ASME labeled.
- C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
- D. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.
- E. Body: Cast iron.
- F. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.
- G. Trim: Hardened stainless steel.
- H. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
- I. Gaskets: Non-asbestos materials.
- J. Capacities and Characteristics:
 1. Steam Flow Rate: .
 2. Inlet Pressure: .
 3. Outlet Set Pressure: .
 4. Pressure Loss (Wide Open): .

2.06 STEAM TRAPS

- A. Thermostatic Traps:
 1. Manufacturers:

- a. Armstrong International.
 - b. Hoffman Specialty.
 - c. Spirax Sarco.
 - d. Watson McDaniels.
 2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
 3. Trap Type: Balanced-pressure.
 4. Bellows: Stainless steel or monel.
 5. Head and Seat: Replaceable, hardened stainless steel.
 6. Pressure Class: 125.
- B. Thermodynamic Traps:
1. Manufacturers:
 - a. Armstrong International.
 - b. Hoffman Specialty.
 - c. Spirax Sarco.
 - d. Watson McDaniels.
 - e. Tunstall Corporation.
 2. Body: Stainless steel with screw-in cap.
 3. End Connections: Threaded.
 4. Disc and Seat: Stainless steel.
 5. Maximum Operating Pressure: 600 psig.
 6. Body and Bolted Cap: ASTM A126, cast iron.
 7. End Connections: Threaded.
 8. Float Mechanism: Replaceable, stainless steel.
 9. Head and Seat: Hardened stainless steel.
 10. Trap Type: Balanced pressure.
 11. Thermostatic Bellows: Stainless steel or monel.
 12. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
 13. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
 14. Maximum Operating Pressure: 125 psig.
- C. Inverted Bucket Traps:
1. Manufacturers:
 - a. Armstrong International.
 - b. Hoffman Specialty.
 - c. Spirax Sarco.
 - d. Watson McDaniels.
 - e. Tunstall Corporation.
 2. Body and Cap: Cast iron.
 3. End Connections: Threaded.
 4. Head and Seat: Stainless steel.
 5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
 6. Bucket: Brass or stainless steel.
 7. Strainer: Integral stainless-steel inlet strainer within the trap body.
 8. Air Vent: Stainless-steel thermostatic vent.
 9. Pressure Rating: 250 psig.

2.07 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Manufacturers:
 - a. Armstrong International.
 - b. Hoffman Specialty.
 - c. Spirax Sarco.
 - d. Watson McDaniels.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 125 psig (861 kPa).
7. Maximum Temperature Rating: 350 deg F (177 deg C).

B. Vacuum Breakers:

1. Manufacturers:
 - a. Armstrong International.
 - b. Hoffman Specialty.
 - c. Spirax Sarco.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-Ring Seal: EPR.
6. Pressure Rating: 125 psig (861 kPa).
7. Maximum Temperature Rating: 350 deg F (177 deg C).

2.08 FLEXIBLE CONNECTORS

A. Stainless-Steel Bellows, Flexible Connectors:

1. Manufacturers:
 - a. Duraflex.
 - b. Flexicraft Industries.
 - c. Mason Industries.
 - d. Metraflex Company.
2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

PART 3 EXECUTION

3.01 APPLICATION

A. Valves

1. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

2. Install safety valves on pressure-reducing stations and elsewhere as required by {RS#396}. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME BPVC-VIII-1, for installation requirements.
3. All valves and specialties associated with clean steam and clean steam condensate shall be constructed of passivized 316 stainless steel.

3.02 INSTALLATION

A. Piping

1. Install piping to permit valve servicing.
2. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
3. Install valves according to Division 20 Section 200523 "General-Duty Valves for Piping."
4. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
5. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
6. Install shutoff valve immediately upstream of each dielectric fitting.
7. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
8. Flash Tank:
 - a. Pitch condensate piping down toward flash tank.
 - b. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
 - c. Install thermostatic air vent at tank top.
 - d. Install safety valve at tank top.
 - e. Install full-port ball valve, and swing check valve on condensate outlet.
 - f. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
 - g. Install pressure gage on low-pressure steam outlet according to Division 20 Section 200519 "Meters and Gages."

B. Steam-Trap

1. Install steam traps in accessible locations as close as possible to connected equipment.
2. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated. Provide a dirt pocket not less than 4 inches long and fitted with threaded cap on the bottom.
3. Install at all low points in steam lines, the bottom of down feed risers, and the return end of all equipment where steam is condensed, shall have traps of proper size and type.
4. Traps for draining heating and ventilating equipment, heating coils, forced flow units, water heaters, and convertors, and all equipment with 15# or less modulating steam service shall be inverted bucket traps.
5. Traps for low points in steam mains shall be high or low pressure bucket traps.
6. Steam trap of a temperature-regulated equipment must not be located at less than 14 inches below the bottom of the coil outlet, and condensate discharge from the trap must flow by gravity, without any lifts in the piping, to the condensate receiver.
7. Lifting of condensate for modulating steam service shall not be acceptable.

C. Pressure-Reducing Valve

1. Install pressure-reducing valves in accessible location for maintenance and inspection.
 2. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
 3. Install gate valves on both sides of pressure-reducing valves.
 4. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.
 5. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 20 Section 200519 "Meters and Gages."
 6. Install strainers upstream for pressure-reducing valve.
 7. Install safety valve downstream from pressure-reducing valve station.
- D. Safety Valve
1. Install safety valves according to ASME B31.1 , "Power Piping." and ASME B31.9 , "Building Services Piping."
 2. Pipe safety-valve discharge without valves to atmosphere outside the building.
 3. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
 4. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

SECTION 233100

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal Duct
 - 1. Material Requirements
 - a. Galvanized Steel
 - 2. Rectangular Metal Duct
 - 3. Round Metal Duct
 - a. Round Single Wall Duct
 - b. Round Connection System
 - c. Round Spiral Duct
 - 4. Connectors, Fittings, Sealants, and Miscellaneous
 - a. Fittings
 - b. Transverse Duct Connection System
 - c. Joint Sealers and Sealants
 - d. Gasket Tape
 - e. Round Duct Joint O-Ring Seals
- B. Flexible Duct
- C. Air Plenums and Casings
 - 1. Access Doors
 - 2. Thermal Panels
 - 3. Fire-Rated Metal Panels

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- C. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- E. {RSTEMP#678}ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus;2019.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

- G. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- H. {RSTEMP#1081}ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials;2019.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- J. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- L. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

1.03 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data for duct materials, duct connections, and sealants.
 - 2. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.
 - 3. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
- B. Closeout Submittals
 - 1. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
 - 2. Manufacturer's Certificate: Certify that the installation of glass fiber ductwork meets or exceeds the manufacturer's recommended fabrication and installation requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A, and SMACNA (DCS) guidelines unless stated otherwise.
- B. Provide metal duct unless otherwise indicated.
- C. Seal and install ductwork to seal Class A, except for welded ductwork.
- D. Fabricate and install ductwork to achieve Leakage classes 3 and 6 for round and rectangular ductwork respectively, unless otherwise noted on Drawings.
- E. Duct Fabrication Requirements:
 - 1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - 2. At Contractor's option, ductwork may be resized to maintain an equivalent air velocity and friction rate, while maintaining a maximum aspect ratio of 4.
 - 3. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - 4. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
 - 5. Where full radius elbows with a radius of not less than 1-1/2 times the width of the duct are not possible, provide round elbows with radius of not less than 1 times the width of

- the duct. If space conditions do not permit a radius elbow to be installed, use square elbows with multi-blade turning vanes and an access door for cleaning of turning vanes.
6. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

A. Material Requirements:

1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating, minimum 24 gauge except where heavier material is required or specified. Ducts to have mil phosphatized finish for surfaces exposed to view.

B. Rectangular Metal Ducts:

C. Round Metal Ducts:

1. General
 - a. Transverse Joints:
 - 1) Transverse joints in ducts larger than 60 inches in diameter: Flanged.
 - 2) Transverse joints in ducts 60 inches and smaller in diameter: flanged, beaded sleeve, or draw band joint.
 - b. Longitudinal Seams:
 - 1) Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2) Fabricate round ducts 90 inches and smaller in diameter with one of the following based on indicated pressure class:
 - (a) Equal to or greater than +/- 4 inches.
 - (1) Butt Weld Seam.
 - (2) Spiral Seam.
 - (b) Equal to or less than +/- 4 inches.
 - (1) Spiral Seam.
 - (2) Lap and Rivet.
 - (3) Grooved Seam.
 - 3) Exposed ductwork shall be spiral seam unless otherwise noted.
 2. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
 - a. Manufacturers:
 - 1) EHG
 - 2) Elgen Manufacturing Company
 - 3) Linx Industries
 - 4) MKT Metal Manufacturing
 - 5) Nordfab Ducting
 3. Round Connection System: Interlocking duct connection system per SMACNA (DCS).
 4. Round Spiral Duct: Round spiral lock seam duct with galvanized steel outer wall.

D. Connectors, Fittings, Sealants, and Miscellaneous:

 1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.

2. Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
 - a. Manufacturers:
 - 1) Carlisle HVAC Products
 - 2) Ductmate Industries
 - 3) Elgen Manufacturing Company
 - 4) MKT Metal Manufacturing
3. Joint Sealers and Sealants:
 - a. Non-hardening
 - (a) Carlisle HVAC Products
 - b. Water resistant
 - (a) Ductmate Industries
 - (b) Design Polymerics
 - (c) Ductmate Industries
 - (d) Nordfab Ducting
 - (e) Elgen Manufacturing Company
 - (f) H.B. Fuller Construction Products
 - c. Mildew and mold resistant
 - (a) EHG
 - d. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - e. VOC Content: Not more than 250 g/L, excluding water.
 - 1) Elgen Manufacturing Company
 - 2) GSI, a DMI Company
 - f. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - g. For Use with Flexible Ducts: UL labeled.
 - 1) Linx Industries
 - 2) MKT Metal Manufacturing
4. Gasket Tape:
 - a. Manufacturers:
 - 1) Design Polymerics
 - 2) Elgen Manufacturing Company
 - b. Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.
5. Round Duct Joint O-Ring Seals:
 - a. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. and shall be rated for 10-inch w.g. static-pressure class, positive or negative.
 - b. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - c. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.03 FLEXIBLE DUCTS

- A. Flexible Air Ducts:
 1. Manufacturers:
 - a. Flexmaster USA, a brand of Masterduct, Inc; Type 1

2. UL 181, Class 1, polyethylene film supported by helically wound spring steel wire.
3. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
4. Pressure Rating: From 10 in-wc to 5 in-wc negative.
5. Maximum Velocity: 5,500 fpm.
6. R-Value: 4.2 when tested in accordance with {RS#678}
7. Temperature Range: Minus 20 to 250 degrees F.
8. Insertion Loss: Minimum attenuation of 33 DB for 9-foot straight length at 8-inch diameter at 500Hz.

2.04 AIR PLENUMS AND CASINGS

- A. Fabricate in accordance with SMACNA (DCS) for working pressure of up to 3-inch w.g. positive or negative and to SMACNA (RIDC) for pressure beyond 3-inch w.g. positive or negative.
 1. Minimum Fabrication Requirements:
 - a. Fabricate acoustic plenum or casing with reinforcing turned inward.
 - b. Provide minimum 16-gauge, 0.059-inch sheet steel back facing and 22-gauge, 0.029-inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers.
 - c. Construct panels 3 inches thick, packed with 4.5 pcf minimum glass fiber insulation media, on inverted channel of 16-gauge, 0.059-inch sheet steel.
 - d. Mount floor-mounted plenum or casings on 4-inch high concrete curbs. At floor, rivet panels on 8-inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18-gauge, 0.052-inch expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.
 - e. Fabricate casings to withstand 133 percent of the indicated static pressure without structural failure. Limit wall and roof deflection at the indicated static pressure to no more than 1/8 inch per foot of width.
 - f. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. and snow load of 30 lbf/sq. ft..
 2. Seismic Performance:
 - a. Casings to withstand the effects of earthquake motions determined in accordance with local Building Codes and ASCE7.
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event;".
 3. Access Doors:
 - a. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
 - b. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.
 - c. Provide clear wire glass observation ports, minimum 6 by 6 inch size.
 4. Thermal Panels:
 - a. Manufacturers:
 - 1) DuraSystems Barriers
 - b. Material: Steel-faced composite panel with noncombustible structural high density mineral fiber core for plenum fabrication.
 - 1) Facing: Galvanized steel (G90), 24 gauge, 0.0275 inch.
 - 2) Finish: Unpainted.
 - 3) Core: Mineral wool board.
 - 4) Structural: Nonload bearing.

- c. Panel Thickness: 2.5 inches.
 - d. R-Value: 12 when tested in accordance with {RS#678}.
- 5. Fire-Rated Metal Panels:
 - a. Manufacturers:
 - 1) DuraSystems Barriers
 - b. Fire Rating: 60 minutes when tested in accordance with {RS#1081}.
 - c. Material: Steel-faced composite panel with noncombustible structural high density mineral fiber core, UL or ETL labeled, nonload bearing fire separations.
 - 1) Facing: Galvanized steel (G90), 24 gauge (0.0275 inch).
 - 2) Finish: Unpainted.
 - 3) Core: Mineral wool board.
 - 4) Structural: Nonload bearing.
 - d. Panel Size: 4 by _____ feet.
 - e. Panel Thickness: 4 inches.
 - f. Sound Transmission Class: 30 when tested in accordance with ASTM E90.
- B. Duct Materials: Use the following materials in the design of ductwork specified in this Section unless otherwise noted on Drawings.
 - 1. General Supply, Return, Transfer, and Exhaust. – galvanized steel.
 - 2. General Exhaust Branch Serving Air Inlet in Shower Areas or Toilet Room with Shower 304 stainless steel.
 - 3. Ductwork for the first 15-feet Downstream of Humidifier 304L stainless steel.
 - 4. Supply, Return, Exhaust serving Natatorium, Pool, or Spa Area 316L stainless steel.
 - 5. Cryogen relief duct: 304 stainless steel.
 - 6. Lab exhaust ductwork:
 - a. Lab general exhaust air ductwork from grilles/air registers to air valves/terminal units; 316 stainless steel.
 - b. Lab exhaust air ductwork from fume hoods or biosafety cabinets to air valves/terminal units to main exhaust ductwork, with minimum 12 fume hoods or biosafety cabinets; 316 stainless steel.
 - c. Lab exhaust risers and main ductwork within shafts: welded 316 stainless steel or PVC coated galvanized steel.
- C. Pressure Classes: Fabricate ductwork and casings to the following pressure classes unless otherwise noted on drawings:
 - 1. Medium pressure ductwork, from fan to terminal units: 0.5-inch higher than air handler's Discharge pressure; minimum 6-inch positive pressure class for supply air ductwork; Minimum 6-inch negative pressure class for exhaust or return air ductwork.
 - 2. Low-pressure ductwork, terminal units to air outlets: plus 2-inch class for supply ductwork, or minus 2-inch for return or exhaust ductwork.
 - 3. Return and exhaust air ducts on systems without terminal units: 0.5-inch more negative than air handler's design pressure; minimum 2-inch negative pressure class.
 - 4. Lab medium pressure exhaust ductwork, from fan to lab air valve/terminal units: negative 6-inch pressure class.
 - 5. Lab low-pressure exhaust ductwork, from lab air valve/terminal units to registers, grilles, and diffusers: negative 2-inch class.
 - 6. Kitchen exhaust ductwork: negative 6-inch pressure class.
 - 7. Hazardous exhaust air ductwork: negative 6-inch pressure class.
 - 8. Ductwork used in smoke management systems: higher of negative 6-inch or 1.5 times max design pressure.
 - 9. Cryogen relief vent: 10-inch pressure class; maximum 5% leakage.

10. Hazardous exhaust header upstream of exhaust fan inlet: 10-inch negative class.

D. General

1. Install, support, and seal ducts in accordance with SMACNA (DCS).
2. Where welded ductwork is indicated, welding shall be continuous.
 - a. Tack welding is unacceptable except as specifically noted.
 - b. For galvanized sheet metal ducts, paint welded area and damaged areas with zinc coating after welding.
3. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
4. Protect ductwork exposed to outside elements by painting or coating it with suitable weatherheat-resistant material.
5. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's Duct Cleanliness for New Construction Advanced Level.
6. Provide ductwork taps and branches off of main and branch ducts at 45 degrees whether shown on Drawings or not (drawings are diagrammatic).
7. Do not cross-break bottom duct panels when ductwork is handling moisture.
8. Roof-mounted ducts shall have standing seams and shall be sealed weather tight.
9. Grade ductwork handling moisture, a minimum of 1:120 back to the source or at low points in the ductwork, provide a 6" deep drain sump and 1-1/4" dia. drain connection with deep seal trap and pipe to drain.
10. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
11. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
12. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.
13. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
14. Use crimp joints with or without bead for joining round duct sizes 8-inch or ____ inch and smaller with a crimp in the direction of airflow.
15. Use double nuts and lock washers on threaded rod supports.
16. Connect terminal units to supply ducts directly or with one one foot maximum length of flexible duct. Do not use flexible duct to change direction.
17. Connect diffusers or light troffer boots to low-pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
18. Set plenum doors at 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.
19. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
20. Louver Fit-out:
 - a. Provide blank-out panels sealing available area of wall-mounted exterior-faced louver when connected ductwork is smaller than actual louver free area, and duct outlet is smaller than the louver frame.
 - b. Use the same duct material painted black on the exterior side, then seal louver frame and duct.
21. Fire Partitions: Provide firestopping sealing. See Section 078400.
22. Duct Insulation: Provide duct insulation. See Section 230713.

23. Painting: Provide surface finish as indicated on drawings. See Sections 099113 and 099123.
24. Routing and Locations
 - a. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate ductwork routing and layout, and make alterations to the ductwork routing and layout to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, alterations may be made so as not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or duct run as shown on the Contract Drawings. In the event, Architect determines that the installed ductwork is inconsistent with the above-mentioned criteria, remove and replace it at no additional cost to the Owner.
 - b. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
 - c. Install ducts with a clearance of 1-inch, plus allowance for insulation thickness. Allow for easy removal of ceiling tiles.
 - d. Do not encase horizontal runs in solid partitions unless specifically indicated.
 - e. Coordinate layout with suspended ceiling, air duct accessories, lighting layout and similar finish work.
 - f. Electrical and IT Equipment Spaces: route ducts to avoid passing through transformer vaults, electrical equipment spaces, IDF/MPOE rooms, and enclosures.
 - g. Route ducts to avoid passing through required exit stairwells, exit passageways, elevator hoistways and machinery rooms, transformer vaults, and electrical equipment rooms and enclosures.
- E. Metal Duct
 1. Paint interiors of metal ducts, that do not have duct liner, for 24-inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible duct material.
- F. Flexible Duct
 1. Flexible Ducts: Connect to metal ducts with adhesive.
- G. Air Plenums and Casings:
 1. Mount floor-mounted casings on 4 inch high concrete curbs.
 2. At floor, rivet panels on 8 inch; or centers to angles.
 3. Where floors are acoustically insulated, provide liner of galvanized 18-gauge, 0.052-inch expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Backdraft and Pressure Relief Dampers.
- B. Barometric Relief Dampers.
- C. Manual Volume Dampers.
- D. Control Dampers.
- E. Fire Dampers.
- F. Smoke Dampers.
- G. Combination Fire and Smoke Dampers.
- H. Flange Connectors.
- I. Turning Vanes.
- J. Duct-Mounted Access Doors.
- K. Duct Access Panel Assemblies.
- L. Flexible Connectors.
- M. Duct Accessory Hardware.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 233100 - HVAC Ducts and Casings.
- B. Section 233600 - Air Terminal Units: Pressure regulating damper assemblies.

1.04 SUBMITTALS

- A. Action Submittals

1. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
2. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
3. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

1.05 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 ASSEMBLY DESCRIPTION

- A. Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- D. Comply with AMCA 500-D testing for damper rating.

2.02 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 1. Galvanized Coating Designation: G90 (Z275).
 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches

2.03 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers:
 1. Air Balance.
 2. American Warming and Ventilating.
 3. Greenheck Fan Corporation.
 4. Nailor Industries.
 5. Pottorff.

- 6. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1000 fpm (5.1 m/s).
- D. Maximum System Pressure: 1-inch wg (0.25 kPa).
 - 1. Temperature Range:- 20 to + 250 deg F
- E. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum with sealed edges.
- F. Blade Action: Parallel.
- G. Blade Seals: Felt.
- H. Blade Axles:
 - 1. Material: Nonferrous metal.
 - 2. Diameter: 0.20 inch (5 mm).
- I. Tie Bars and Brackets: Galvanized steel.
- J. Return Spring: Adjustable tension.
- K. Bearings: Steel ball.
- L. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage minimum.
 - b. Sleeve Length: 6 inches minimum.
 - 6. Screen Mounting: Rear mounted.
 - 7. Screen Material: Galvanized steel.
 - 8. Screen Type: Bird.
 - 9. 90-degree stops.

2.04 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers:
 - 1. Air Balance.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries.
 - 5. Pottorff.
 - 6. Ruskin Company.
 - 7. Vent Products Company.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 1000 fpm (5.1 m/s).
- D. Maximum System Pressure: 2-inch wg (0.5 kPa).

- E. Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- F. Blades:
 - 1. Multiple, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum.
 - 2. Maximum Width:.6 inches
 - 3. Action: Parallel.
 - 4. Balance: Gravity.
 - 5. Eccentrically pivoted.
- G. Blade Seals: Vinyl.
- H. Blade Axles: Galvanized steel.
- I. Tie Bars and Brackets:
 - 1. Material: Aluminum.
 - 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic.
- L. Accessories:
 - 1. Flange on intake.
 - 2. Adjustment device to permit setting for varying differential static pressures.

2.05 MANUAL VOLUME DAMPERS

- A. Manufacturers:
 - 1. Air Balance.
 - 2. American Warming and Ventilating.
 - 3. Greenheck Fan Corporation.
 - 4. METALAIRE.
 - 5. Nailor Industries.
 - 6. Pottorff.
 - 7. Ruskin Company.
- B. Standard, Steel, Manual Volume Dampers:
 - 1. Standard leakage rating , with linkage outside airstream .
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames:
 - a. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel,0.064 inch thick.
 - 5. Blade Axles: Galvanized steel.
 - 6. Bearings:
 - a. Oil-impregnated bronze.

- b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 7. Tie Bars and Brackets: Galvanized steel.
- C. Standard, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers:
 - a. Air Balance.
 - b. American Warming and Ventilating.
 - c. Greenheck Fan Corporation.
 - d. METALAIRE.
 - e. Nailor Industries.
 - f. Pottorff.
 - g. Ruskin Company.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Tie Bars and Brackets: Aluminum.
- D. Low-Leakage, Steel, Manual Volume Dampers:
 - 1. Manufacturers:
 - a. Air Balance.
 - b. American Warming and Ventilating.
 - c. Flexmaster U.S.A.
 - d. Greenheck Fan Corporation.
 - e. McGill AirFlow.
 - f. METALAIRE.
 - g. Nailor Industries.
 - h. Pottorff.
 - i. Ruskin Company.
 - j. Vent Products Company.
 - k. Flex-Tek Group.
 - 2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat shaped.
 - b. 94-inch- (2.4-mm-) thick, galvanized sheet steel.
 - c. Mitered and welded corners.

- d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Blade Seals: Felt.
 - 9. Jamb Seals: Cambered stainless steel.
 - 10. Tie Bars and Brackets: Galvanized steel.
 - 11. Accessories:
 - a. Include locking device with 2" stand-off bracket to hold single-blade dampers in a fixed position without vibration.
- E. Low-Leakage, Aluminum, Manual Volume Dampers:
- 1. Manufacturers:
 - a. Air Balance Inc.
 - b. American Warming and Ventilating.
 - c. METALAIRE.
 - d. Nailor Industries.
 - e. Pottorff.
 - f. Ruskin Company.
 - 2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch w.g. less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Blade Seals: Felt.
 - 9. Jamb Seals: Cambered Stainless steel.
 - 10. Tie Bars and Brackets: Galvanized steel.
 - 11. Accessories:
 - a. Include locking device with 2" stand-off bracket to hold single-blade dampers in a fixed position without vibration.
- F. Jackshaft:
- 1. Size: 1-inch diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- G. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 2. Include center hole to suit damper operating-rod size.
 3. Include elevated platform for insulated duct mounting.

2.06 CONTROL DAMPERS

- A. Manufacturers:
1. American Warming and Ventilating.
 2. Cesco Products.
 3. Duro Dyne.
 4. METALAIRE.
 5. Nailor Industries.
 6. Ruskin Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
1. Hat shaped.
 2. 94-inch- (2.4-mm-) thick, galvanized sheet steel .
 3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 6 inches (152 mm).
 2. Parallel-blade design.
 3. Galvanized steel.
 4. 4 inch (1.62 mm) thick single skin.
 5. Blade Edging: Closed-cell neoprene.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch- diameter; Galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From- 40 to + 200 deg F
- F. Bearings:
1. Oil-impregnated bronze.
 2. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 3. Thrust bearings at each end of every blade.

2.07 FIRE DAMPERS

- A. Manufacturers:
1. Air Balance Inc.

2. METALAIRE.
 3. Nailor Industries.
 4. Ruskin Company.
 5. Vent Products Company,
- B. Type: Dynamic Static; rated and labeled according to UL 555 by an NRTL.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.05 (1.3 mm) thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.024-inch- (0.61-mm) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F 212 deg F (100 deg C) rated, fusible links.
- J. Heat-Responsive Device: Electric link and switch package, factory installed, 165 deg F (74 deg C) rated.

2.08 SMOKE DAMPERS

- A. Manufacturers:
1. Air Balance.
 2. Nailor Industries.
 3. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: Integral, factory wired for single-point connection.
- D. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded interlocking, gusseted corners and mounting flange.
- E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel.
- F. Leakage: Class I.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, 0.039-inch- (1.0-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- I. Damper Motors: Two-position Modulating action.

- J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 200513 "Common Motor Requirements for Mechanical Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at- 40 deg F
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. 2 size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- K. Accessories:
 - 1. Auxiliary switches for signaling.
 - 2. Momentary test switch mounted.

2.09 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Air Balance Inc.
 - 2. Nailor Industries.
 - 3. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch w.g.) static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded interlocking, gusseted corners and mounting flange.
- F. Heat-Responsive Device: Resettable, 165 deg F (74 deg C) rated, fusible links.
- G. Heat-Responsive Device: Electric Pneumatic resettable link device and switch package, factory installed, rated.
- H. Smoke Detector: Integral, factory wired for single-point connection.
- I. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- (1.6-mm-) thick, galvanized sheet steel.
- J. Leakage: Class I.
- K. Rated pressure and velocity to exceed design airflow conditions.

- L. Mounting Sleeve: Factory-installed, 0.039-inch- (1.0-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- M. Master control panel for use in dynamic smoke-management systems.
- N. Damper Motors: Two-position Modulating action.
- O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 200513 "Common Motor Requirements for Fire Suppression, Plumbing, and Mechanical Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at - 40 deg F
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. 2 size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- P. Accessories:
 - 1. Auxiliary switches for signaling.
 - 2. Momentary test switch mounted.

2.10 FLANGE CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries.
 - 2. Elgen.
 - 3. Ward Industries, Inc.
- B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.11 TURNING VANES

- A. Manufacturers:
 - 1. Ductmate Industries.
 - 2. METALAIRE.
 - 3. Ward Industries.

- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall.
- F. Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

2.12 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers:
 - 1. American Warming and Ventilating.
 - 2. Ductmate Industries.
 - 3. Nailor Industries.
 - 4. Pottorff.
 - 5. Ruskin.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches : Three hinges and and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches : Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
 - 1. Door and Frame Material: Galvanized sheet steel.
 - 2. Door: Single wall with metal thickness applicable for duct pressure class.
 - 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 - 4. Factory set at 3.0- to 8.0-inch wg (800 to 2000 Pa).
 - 5. Doors close when pressures are within set-point range.

6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1 inch thick, fibrous-glass or polystyrene-foam board.

2.13 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers:
 1. Ductmate Industries.
 2. Flame Gard.
 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F
- F. Minimum Pressure Rating: 10-inch w.g., positive or negative.

2.14 FLEXIBLE CONNECTORS

- A. Manufacturers:
 1. Ductmate Industries.
 2. Ventfabrics.
 3. Ward Industries.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 1. Minimum Weight: 26 oz./sq. yd.
 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 3. Service Temperature: - 40 to + 200 deg F
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 1. Minimum Weight: 24 oz./sq. yd.
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 1. Minimum Weight: 16 oz./sq. yd. .
 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F.

- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4 inch movement at start and stop.

2.15 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of Pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.01 APPLICATION

- A. Backdraft and Pressure Relief Dampers
1. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- B. Manual Volume Dampers
1. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - a. Install steel volume dampers in steel ducts.
 - b. Install aluminum volume dampers in aluminum ducts.
 - c. Install stainless steel volume dampers in stainless steel ducts and PVC coated steel ducts.
- C. Duct-Mounted Access Doors:
1. Provide in the following locations
 - a. On both sides of duct coils.
 - b. Upstream and downstream from duct filters.
 - c. At outdoor-air intakes and mixed-air plenums.
 - d. At drain pans and seals.
 - e. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

- f. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - g. At each change in direction and at maximum 50-foot spacing.
 - h. Upstream and downstream from turning vanes.
 - i. Upstream or downstream from duct silencers.
 - j. Control devices requiring inspection.
 - k. Elsewhere as indicated.
 - 2. Access Door Sizes:
 - a. Two-Hand Access: 12 by 6 inches.
 - b. Head and Hand Access: 18 by 10 inches.
 - c. Head and Shoulders Access: 21 by 14 inches.
 - d. Body Access: 25 by 14 inches.
 - e. Body plus Ladder Access: 25 by 17 inches.
- D. Flexible Connectors
 - 1. Install flexible connectors to connect ducts to equipment.
- E. Duct Accessory Hardware
 - 1. Instrument Test Holes:
 - a. Install test holes at fan inlets and outlets and elsewhere as indicated.
 - b. Install duct test holes where required for testing and balancing purposes.

3.02 INSTALLATION

- A. General
 - 1. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
 - 2. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
 - 3. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.
- B. Manual Volume Dampers: Set dampers to fully open position before testing, adjusting, and balancing.
- C. Fire, Smoke and Combination Fire and Smoke Dampers: Install according to UL listing.
- D. Duct-Mounted Access Doors:
 - 1. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 2. Label access doors according to Division 20 Section 200553 "Mechanical Identification" to indicate the purpose of access door.
- E. Flexible Connectors: For fans developing static pressures of 5-inch w.g. and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Manual and Control Dampers: Operate dampers to verify full range of movement.
2. Duct-Mounted Access Doors: Inspect locations of access doors and verify that purpose of access door can be performed.
3. Fire, Smoke, and Combination Fire and Smoke Dampers: Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Turning Vanes: Inspect turning vanes for proper and secure installation.

SECTION 233413
AXIAL HVAC FANS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Mixed flow fans.
- B. Residential ceiling fans.

1.02 RELATED REQUIREMENTS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment.
- B. Section 230548 - Vibration and Seismic Controls for HVAC.
- C. Section 233300 - Air Duct Accessories: Backdraft dampers - metal.
- D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1910 - Occupational Safety and Health Standards.
- B. {RSTEMP#79}ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.{CH#100447}.
- C. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings.
- D. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program.
- E. AMCA 99 - Standards Handbook.
- F. AMCA 204 - Balance Quality and Vibration Levels for Fans.
- G. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- H. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans.
- I. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- J. NEMA MG 00001 - Motors and Generators.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate assembly of axial fans and accessories including fan curves with specified operating point plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.07 FIELD CONDITIONS

- A. Do not use permanent fans for ventilation during construction.

PART 2 PRODUCTS

2.01 MIXED FLOW FANS

- A. Manufacturers:
 - 1. Loren Cook Company; _____: www.lorencook.com/#sle.
 - 2. Twin City Fan & Blower; QSL: www.tcf.com/#sle.
 - 3. Greenheck :www.greenheck.com.
- B. Performance Requirements:
 - 1. Performance Ratings: AMCA 210 or AMCA 204 certified, bearing respective rating seal.
 - 2. Sound Ratings: AMCA 301, tested to AMCA 300, bearing respective sound ratings seal.
 - 3. Fabrication: Comply with AMCA 99.
 - 4. Performance Base: Sea level conditions.
 - 5. Temperature Limit: Maximum 300 degrees F.
- C. Hub and Impeller:
 - 1. Airfoil Impeller Blades: Adjustable die-cast aluminum alloy glass reinforced polyester resin.
 - 2. Hub: Die-cast aluminum alloy or cast iron hub or with belt drive of spun, welded steel, bored and keyed to shaft; to facilitate indexing of blade angle with automatic adjustment stops.
 - 3. Controllable Pitch Assemblies: Incorporate ball bearing counterbalanced blade and variable pitch assembly into hub with mechanical link to casing exterior mounted actuator, or pneumatic or electric actuator incorporated within hub.
 - 4. Cast Components: X-ray components after fabrication and statically and dynamically balance assembly before attachment to motor or shaft.
- D. Casing:
 - 1. Fabricate casing of 1/4 inch steel for fans 40 inch in diameter and smaller and 3/8 inch steel for larger fans.

2. Continuously weld, with inlet and outlet flange connections, and motor or shaft supports. Incorporate flow-straightening guide vanes for fans specified for static pressures greater than 1 in-wc.
 3. Finish with one coat enamel applied to interior and exterior.
- E. Bearings and Drives:
1. Bearings: Heavy-duty pillow block type, self-aligning, grease-lubricated ball bearings, with {rs\#1}, L-10 life at 50,000 hours.
 2. Shafts: Hot rolled steel, ground and polished, with keyway; protectively coated with lubricating oil.
 3. V-Belt Drive:
 - a. Type: Cast iron or steel sheaves, dynamically balanced, and keyed.
 - b. Motors Rated at 15 hp and Lower: Variable and adjustable pitch sheave so required rpm can be reached with sheaves set at mid-position.
 - c. Motor Rated at 20 hp or Higher: Fixed sheave, matched belt, and drive at manufacturer recommended rating or minimum of 1.5 times motor nameplate rating.
 - d. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
- F. Lubrication: Extend lubrication fittings to outside of casing.
- G. Accessories:
1. Provide fans with redundant variable speed drives. Variable speed drives shall meet specification section 230934 Variable Frequency Motor Controllers for HVAC.

2.02 RESIDENTIAL CEILING FANS

- A. Construction: Aluminum blades, statically and dynamically balanced, locked to shaft, directly connected to direct-drive, reversible motor.
- B. Mounting Options: Ceiling.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install with resilient mountings and flexible electrical leads; see Sections 230548 and 260583.
- C. Install flexible connections between axial fan inlet and discharge ductwork; see Section 233300. Ensure metal bands of connectors are parallel with a minimum one inch flex between ductwork and axial fan while running.

SECTION 233423

HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Utility Set Fans.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 230513 - Common Motor Requirements for HVAC Equipment.
- B. Section 230548 - Vibration and Seismic Controls for HVAC.
- C. Section 233100 - HVAC Ducts and Casings.
- D. Section 233300 - Air Duct Accessories: Backdraft dampers.

1.04 REFERENCE STANDARDS

- A. {RSTEMP#79}
- B. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- C. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans.
- D. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.
 - 2. Manufacturer's Instructions: Indicate installation instructions.
- B. Operation and Maintenance Materials
 - 1. Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.06 QUALITY ASSURANCE

- A. Sound-Power Level Ratings:

1. Comply with AMCA 301.
 2. Factory test fans according to AMCA 300.
 3. Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210.

1.07 COORDINATION

- A. Coordinate fan roof curbs and service utilities installation according to fan size.

1.08 EXTRA MATERIALS

- A. Extra Fan Belts: One set for each individual fan.

PART 2 PRODUCTS

2.01 GENERAL

1. Greenheck.
 2. Loren Cook Company.
 3. New York Blower Company.
 4. PennBarry.
- B. Motors
1. Enclosure Type: Totally enclosed, fan cooled.

2.02 UTILITY SET FANS

- A. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
1. Housing Discharge Arrangement: Adjustable to eight standard positions.
- B. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
1. Blade Materials: Steel.
 2. Blade Type: Backward inclined.
 3. Spark-Resistant Construction: Type A.
- C. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
- D. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with {RS#79} ABMA 9, L50 of 200,000 hours.
1. Extend grease fitting to accessible location outside of unit.
- E. Belt Drives (when scheduled on drawings):
1. Factory mounted, with final alignment and belt adjustment made after installation
 2. Service Factor Based on Fan Motor Size:1.5.
 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 5. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Access Door: Gasketed door in scroll with latch-type handles.
4. Inlet Screens: Removable wire mesh.
5. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
6. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
7. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
8. Provide fans with redundant variable speed drives. Variable speed drives shall meet specification section 230934 Variable Frequency Motor Controllers for HVAC.

2.03 CENTRIFUGAL WALL VENTILATORS

2.04 CEILING-MOUNTED VENTILATORS

2.05 IN-LINE CENTRIFUGAL FANS

2.06 PROPELLER FANS

PART 3 EXECUTION

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 20 Section 200553 "Mechanical Identification."

3.02 CONNECTIONS

- A. Duct Connections
 1. Make final duct connections with flexible connectors.
 2. Install ducts adjacent to power ventilators to allow service and maintenance.

3.03 START UP SERVICE

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.
 11. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Division 20 Section 200593 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

SECTION 233713
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General Grilles, Registers and Diffusers
 - 1. Rectangular Ceiling Diffusers.
 - 2. Perforated Face Ceiling Diffusers.
 - 3. Ceiling Slot Diffusers.
 - 4. Ceiling Supply Registers/Grilles.
 - 5. Ceiling Exhaust And Return Registers/Grilles.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.04 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
 - 2. Record actual locations of air outlets and inlets.

1.05 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.

PART 2 PRODUCTS

2.01 GENERAL GRILLES, REGISTERS AND DIFFUSERS

- 1. Krueger
 - 2. Metalaire
 - 3. Price Industries
 - 4. Titus
- B. Rectangular Ceiling Diffusers

1. Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.
 2. Devices shall be designed for variable.
 3. Connections: Round.
 4. Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.
 5. Fabrication: Steel with baked enamel finish.
 6. Color: As indicated.
 7. Color: As selected by Architect from manufacturer's standard range.
 8. Accessories: Provide radial opposed blade, butterfly, and combination splitter volume control damper; removable core, sectorizing baffle, safety chain, wire guard, equalizing grid, operating rod extension, anti-smudging device, and gaskets for surface mounted diffusers with damper adjustable from diffuser face.
- C. Perforated Face Ceiling Diffusers
1. Type: Perforated face with fully adjustable pattern and removable face.
 2. Devices shall be designed for variable.
 3. Frame: Surface mount type. In plaster ceilings, provide plaster frame and ceiling frame.
 4. Fabrication: Steel with steel frame and baked enamel finish.
 5. Fabrication: Stainless steel.
 6. Color: As indicated.
 7. Color: As selected by Architect from manufacturer's standard range.
 8. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.
- D. Ceiling Slot Diffusers
1. Type: Continuous 1/2 inch wide slot, 1 slots wide, with adjustable vanes for left, right, or vertical discharge; integral ceiling fire damper.
 2. Fabrication: Aluminum extrusions with factory clear lacquer finish.
 3. Color: As indicated.
 4. Color: To be selected by Architect from manufacturer's standard range.
 5. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket, mitered end border.
 6. Plenum: Integral, galvanized steel, insulated.
- E. Ceiling Supply Registers/Grilles
1. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.
 2. Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
 3. Construction: Made of aluminum extrusions with factory enamel finish.
 4. Construction: Made of stainless steel.
 5. Color: As indicated.
 6. Color: As selected by Architect from manufacturer's standard range.
 7. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- F. Ceiling Exhaust and Return Registers/Grilles
1. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.
 2. Frame: 1-1/4 inch margin with countersunk screw mounting.

3. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
4. Fabrication: Stainless steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame.
5. Color: As indicated.
6. Color: To be selected by Architect from manufacturer's standard range.
7. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
8. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black, see Section 099123.

SECTION 234000
HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disposable, extended area panel filters.
- B. Extended surface high efficiency media filters.
- C. High-efficiency particulate (HEPA) air filters.
- D. High-containment housing for high-efficiency particulate air filter. (Bag-In / Bag-Out)
- E. Filter frames and housings.
- F. Filter gauges.
- G. Ultraviolet lights.
- H. Bag-In / Bag-Out Containment Housings

1.02 RELATED REQUIREMENTS

- A. Section 253523 - Integrated Automation Control Dampers: Industrial-grade, bubble-tight dampers.

1.03 REFERENCE STANDARDS

- A. ACGIH - Ultraviolet Radiation: TLV(R) Physical Agents 7th Edition Documentation.
- B. AHRI 851 (SI) - Performance Rating of Commercial and Industrial Air Filter Equipment.
- C. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- D. MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components, and Related Products: Performance-Test Methods.
- E. UL 153 - Portable Electric Luminaires.
- F. UL 508A - Industrial Control Panels.
- G. UL 586 - High Efficiency, Particulate, Air Filter Units.
- H. UL 900 - Standard for Air Filter Units.
- I. UL 1598 - Luminaires.
- J. UL 1995 - Heating and Cooling Equipment.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.

- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.01 FILTER MANUFACTURERS

- A. American Air Filter Company, Inc: www.aafintl.com/#sle.
- B. Camfil, a company of the The Camfil Group: www.camfil.us/#sle.
- C. Filtration Group, www.filtrationgroupiaq.com

2.02 PERFORMANCE REQUIREMENTS

- A. Comply with the rating requirements in AHRI 851 (SI).

2.03 DISPOSABLE, EXTENDED AREA PANEL FILTERS

- A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
 - 1. Frame: Non-flammable.
 - 2. Nominal size: 12 by 24 inches.
 - 3. Nominal thickness: 1 inch.
- B. Minimum Efficiency Reporting Value (MERV): 8, when tested in accordance with ASHRAE Std 52.2.
- C. Rating, per ASHRAE Std 52.2:
 - 1. Weight Arrestance: 85 percent.
 - 2. Initial resistance at 500 fpm face velocity: 0.20 in-wc.
 - 3. Recommended final resistance: 0.9 in-wc.

2.04 EXTENDED SURFACE HIGH EFFICIENCY MEDIA FILTERS

- A. Media: Pleated, water-resistant glass fiber with aluminum separators; in 16 gauge, 0.0598 inch steel holding frame with corrosion resistant coating.
 - 1. Nominal Size: 24 by 24 by 6 inches deep.
- B. Minimum Efficiency Reporting Value (MERV): 15, when tested in accordance with ASHRAE Std 52.2.
- C. Performance Rating, per ASHRAE Std 52.2:
 - 1. MIL-STD-282 Test 0.3 Micron Dioctyl Phthalate Smoke (DOP) Efficiency: 99 percent.
 - 2. Initial Resistance at 150 fpm Face Velocity: 0.35 in-wc.
 - 3. Recommended Final Resistance: 1.5 in-wc.

2.05 HIGH EFFICIENCY PARTICULATE (HEPA) AIR FILTERS

- A. Media: UL 586, pleated, water-resistant glass fiber with aluminum separators:
 - 1. Holding Frame: Plywood.
 - 2. Media to Frame Side Bond: Polyurethane foam.
 - 3. Face Gasket: Neoprene expanded rubber.
 - 4. Nominal Size: 24 by 24 by 12 inches deep.
- B. Performance Rating:
 - 1. Efficiency: 99.97 percent at 0.3 micro-meter and higher when tested in accordance with the DOP-smoke (Diocetyl Phthalate) Penetration Test on MIL-STD-282.
 - 2. Leakage Scan Tested: Certified as pinhole-free at:
 - a. Air velocity capacity of 500 fps.
 - b. Resistance from 0.5 in-wc to 2.0 in-wc.

2.06 HIGH-CONTAINMENT HOUSING FOR HIGH-EFFICIENCY PARTICULATE AIR FILTER (BAG-IN / BAG-OUT)

- A. Basis of Design: Filtration Group IAQ Aerostar HEPA Seal BIBO Housing.
- B. Floor-mounted, self-contained high-pressure housing, 11 and 14 gauge, T304 stainless steel. To hinder contaminations and air bypass, the housing shall be fully seam welded with a brokenchannel for the filters instead of aluminum extrusion. Welds shall be ground smooth. There shall be a 1-1/2" flange around the air entering and leaving sides to accommodate connection to ductwork and air handling equipment. No holes shall be drilled or punched, assuring leak-free field installation. Upstream and downstream transitions to dampers or duct work shall be fully welded to the housing. All hardware on the housing and mechanical components of the filter clamping mechanism shall be 300 Series Stainless Steel except for the threaded nuts that shall be brass and the access doorknobs that shall be aluminum and designed to prevent galling of threads.
- C. The housings shall have a removable access door for each tier of HEPA filters and a separate access door for each tier of prefilters. Both the removal rod and locking arm shall be operated through the door opening. A rubber lip on the perimeter of the door shall affect a seal between the housing and the access door. There shall be four (4) tie down latches per access door which shall be spring loaded in such a manner that they pivot away from the bag-out port after release so they do not impede the bag-out process. The filter locking mechanism and access door shall interface in such a manner that the door cannot be closed until the filters are correctly seated in the housing and sealed on the knife edge. Each door shall be equipped with a metal pocket for the housing instruction manual which shall be provided with the housing and shall contain complete, detailed and separate instructions on the one, two or three filter wide arrangements including installation, operation, maintenance and spare parts. The manual shall be contained in a weatherproof bag. Each metal pocket on the access door shall have a painted aluminum label with the manufacturer's name, the housing model number, prefilter model number, HEPA filter model number, PVC bag number(s), manufacturer's order number and the owner's ventilation system number permanently engraved on the label to facilitate re-ordering of critical replacement components and parts.
- D. On the upstream side of each prefilter and HEPA filter position there shall be a smooth inlet design that provides a minimum 3/4 inch depth recess around the upstream perimeter of the prefilter or HEPA filter to limit the buildup of contaminants in crevices or fillets that would have been caused by the junction of the filter's integral frame and the housing wall. All flanges of the housing that connect to the system shall turn to the outside and bolt connections to the ductwork shall be in accordance with the manufacturer's instructions.

- E. The filter locking mechanism in the housing shall be a replaceable locking tray. All components of the filter locking mechanism shall be Type 304 stainless steel. All housings shall have a locking arm in each tier to operate the mechanism which engages and disengages the filters on the internal sealing frame. Housings with two or more filters in a tier shall have a removal rod in each tier to draw the filters to the change-out position. The rod is part of the filter locking mechanism and shall be replaceable.
- F. The housings shall have a bagging ring around each filter access port. The bagging rings shall have two (2) continuous ribs to secure the PVC change-out bag. One (1) PVC change-out bag shall be furnished for each filter access port. Each bag shall be a durable 8 mil thick yellow transparent PVC material. The bag shall have a smooth, taffeta texture finish and shall not stick together. An elastic shock cord shall be hemmed into the mouth of the bag so that it fits securely when stretched around the bagging ring. Three (3) glove sleeves shall be incorporated into the bag to facilitate handling of the filters. A nylon safety strap shall be provided with each access port to prevent the bag from slipping off the bagging ring during the change-out procedure. A nylon clinching strap shall also be provided with each access port to tie off the slack in the bag while the ventilation system is operating.
- G. The filter-to-housing seal shall be affected by means of a continuous knife edge on the sealing frame of the housing that mates to a continuous perimeter channel on the face of the filter which has been filled with a viscous, non-drying fluid (liquid gel seal type).
- H. Access Door Arrangements: Access door arrangements shall be as indicated on the drawings. Arrangements comprising 1, 2 or 3 filters wide in the bank shall have access doors on one side only. Arrangements comprising 4, 5 or 6 filters wide in the bank shall have access doors on both sides with the side-by-side housings factory welded together. Separate access doors shall be provided for each stage of filtration.
- I. Filter Removal Trays: Removable bag-out trays shall be provided to support the filters during the change-out procedure. Each shelf shall be fastened to the housing by means of the door latches following the removal of the doors.
- J. Low-Leak Filter Dampers: When indicated on the drawings, provide low-leak filter dampers. The low-leak filter dampers shall be designed to provide virtually leak-free performance by utilizing two sets of expanding blades. Each blade shall have its own drive shaft and shall be manually operated. A cam device shall be provided on the drive shaft to maintain blade pressure against the sealing surface. The damper shall be designed to mount to the flange of the 1 x 1, 1 x 2 and 1 x 3 housings for shut off of one or more tiers during filter change. The tight shut off feature shall allow the filter change to take place without the operator being hampered by the negative pressure usually present inside the system, which causes the bag to collapse.
- K. Drilled Flanges: Flanges shall be drilled in the manufacturer's standard pattern, unless otherwise indicated. The bolt holes shall be 7/16 inch diameter drilled in the housing flanges on the air-entering and air-exiting sides of the housing. The flanges shall be reinforced with flat stock of the same type material as the housing so that the housing and the reinforcement shall have a minimum thickness of ¼ inch. The spacing shall be the manufacturer's standard bolt-hole pattern, not to exceed 4 inches on center between bolt holes.
- L. Lifting Lugs: Lifting lugs shall be provided for the top of each housing. They shall be 3/16 inch Type 304 stainless steel with a 2 inch diameter lifting eye.
- M. Outdoor Weather Caps: For outdoor service, weather caps shall be provided and shall be welded and sealed with silastic to the top of each housing. The weather caps shall be fabricated of the same material and shall have the same finish as the housings.

- N. Static Pressure Ports: Static pressure ports shall be located on the top of the housing upstream and downstream of the prefilters and HEPA filters. Connections shall be 1/4 inch IPS pipe nipples with caps, Type 304 stainless steel.
- O. DOP Test Ports: An upstream sample port, 1/2 inch IPS pipe nipple with cap, shall be welded to the top of the housing upstream of the HEPA filters. The manufacturer shall supply a second 1/2 inch half-coupling with plug for the downstream sample and a 2 inch half-coupling with plug for the DOP inlet. The downstream sample port and the DOP inlet shall be installed by the Contractor and shall be located unobstructed ten duct diameters downstream and upstream, respectively, of the HEPA filter bank. All connections shall be Type 304 stainless steel.
- P. Banding Kits: Banding kits shall be provided for secure clamping off of the bags between the housing and the spent filters.
- Q. Factory Testing: The housing shall be factory tested for filter fit, operation sealing surface flatness and leak tightness. Both the filter sealing surface flatness and the complete assembly pressure shall be tested by the "Pressure Decay Method" in accordance with ASME N510-1995, Testing of Nuclear Air Treatment Systems. Pressure readings shall be recorded in one minute intervals for 5 minutes with a maximum leak rate of 0.0005 CFM per cubic foot of housing volume at 10 inches w.g.
- R. The prefilters, HEPA filters, bags, straps and instruction manuals shall be shipped separately from the housings.
- S. Housing-fitted inlet and outlet transitions to flanged bubble-tight isolation dampers in compliance with Section 253523 fitted with pneumatic operator with manual override.
- T. Housing to include valved inlet and outlet test ports to sample air stream and inject decontaminating products.
- U. Housing to include ribbed banging ring behind filter access door to facilitate the contactless filter bag-in bag-out procedure.
- V. Housing-mounted pressure gauge with tubing and fittings per filter section scaled to have highest value at least 2.0 in-wc above maximum rated filter resistance capacity.

2.07 FILTER FRAMES AND HOUSINGS

- A. General: Fabricate filter frames and supporting structures of 16 gauge, 0.0598 inch galvanized steel or extruded aluminum T-section construction with necessary gasketing between frames and walls.
- B. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size for 24 by 24 inches filter media, minimum 2 inches thick; for extended surface and high efficiency particulate air filters, provide for upstream mounting of panel filters.
- C. Side Servicing Housings: Flanged for insertion into ductwork, of reinforced 16 gauge, 0.0598 inch galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extruded aluminum tracks or channels for primary secondary filters with positive sealing gaskets.

2.08 FILTER GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. H.O. Trerice Co: www.trerice.com/#sle.

3. Weiss Instruments: www.weissinstruments.com/#sle.
- B. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, range 0 to 0.5 in-wc, 2 percent of full scale accuracy.
- C. Accessories: Static pressure tips with integral compression fittings, 1/4 inch aluminum tubing, 2-way or 3-way vent valves.

2.09 ULTRAVIOLET LIGHTS

- A. Manufacturers:
 1. Sanuvox Technologies Inc; Biowall: www.sanuvox.com/#sle.
 2. Steri-Aire, Inc; _____: www.steril-aire.com/#sle.
 3. UV Resources; RLM Xtreme: www.uvresources.com/#sle.
- B. Tested and recognized by UL 153, UL 1598, and UL 1995 for luminaries, heating, and cooling equipment.
- C. UV-C Short Wave Light Array Performance: Provide not less than 190 microwatts/sq in.
- D. Factory assemble and test UV-C fixtures in air handling unit.
- E. Materials:
 1. Provide UV-C resistant polymeric materials or shield from direct or indirect UV-C light with UV-C tolerant material.
 2. UV-C Fixtures: Stainless steel to resist corrosion.
- F. Lamp Life: 9000 hours minimum with no more than 20 percent loss of output after two years of continuous use.
- G. Mount UV-C fixtures on slide-out rack to enable servicing from unit exterior via access door.
- H. View Port: Provide with cover to allow viewing of UV-C light array.
- I. Control Panel: Provide control panel for each UV-C light array.
 1. Comply with UL 508A.
 2. Use components marked with minimum SCCR (Short Circuit Current Rating).
 3. Provide enclosure with NEMA 4X rating for prevention of corrosion and water ingress.
 4. Provide control panel with current sensor to indicate status of UV-C array.
- J. Safety Features:
 1. Treat view port and other windows to assure UV-C energy emitted is below threshold limit specified by American Conference of Governmental Industrial Hygienists (ACGIH).
 2. Provide mechanical interlock switch to disconnect power to UV-C fixtures when opening access door.
 3. Provide externally mounted, on-off, disconnect, and shutoff switch with lockout/tagout that disconnects UV-C power and prevents unwanted operation of UV-C lights.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.

- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Install filter gauge static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and level.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.
- E. Provide filter gauges on filter banks, installed with separate static pressure tips upstream and downstream of filters.
- F. UV-C system to be commissioned by manufacturer field representative.

SECTION 237316

CUSTOM CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

1. Fan, Drive, and Motor Section.
2. Coil Section.
3. Air Filtration Section.
4. Dampers.
5. Humidifiers.
6. Air Blender.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

1.04 REFERENCE STANDARDS

- A. {RSTEMP#79}
- B. AMCA 204 - Balance Quality and Vibration Levels for Fans.
- C. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- D. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans.
- E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- F. AMCA 500 - Laboratory Methods of Testing Louvers for Rating.
- G. ARI 410 - Performance Rating of Forced-circulation Air-cooling and Air-heating Coils.
- H. ARI 430 - Performance Rating of Central Station Air-handling Unit Supply Fans.
- I. ASHRAE 33 - Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils.
- J. ASHRAE Std 52.1 - Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter.
- K. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- L. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality.

- M. ASME N510 - Testing of Nuclear Air Treatment Systems.
- N. {RSTEMP#591}
- O. {RSTEMP#592}
- P. {RSTEMP#818}
- Q. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- R. IESNA 90.1 - Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings.
- S. NEMA MG 00001 - Motors and Generators.
- T. NFPA 70 - National Electrical Code.
- U. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.05 SUBMITTALS

A. Action Submittals

1. Product Data: For each air-handling unit indicated.
 - a. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - a. Fans:
 - 1) Certified fan-performance curves with system operating conditions indicated.
 - 2) Certified fan-sound power ratings.
 - 3) Fan construction and accessories.
 - 4) Motor ratings, electrical characteristics, and motor accessories.
 - b. Certified coil-performance ratings with system operating conditions indicated.
 - c. Dampers, including housings, linkages, and operators.
 - d. Filters with performance characteristics.
 - e. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.
 - f. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - g. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - h. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
3. Source quality-control reports.
4. Field quality-control reports.
5. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

B. Informational Submittals

C. Closeout Submittals

D. Operation and Maintenance Materials

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Filters: One set(s) for each air-handling unit.
 - b. Gaskets: One set(s) for each access door.

- c. Fan Belts: One set(s) for each air-handling unit fan.

E. Record Documents

1.06 WARRANTIES

- A. Provide an additional 12 month limited parts only warranty in addition to base project warranty requirements.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE Std 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.08 PRE-INSTALLATION TESTING

- A. The manufacturer shall perform an air performance test on one selected unit in accordance to ANSI/AMCA Standard 210-16, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance rating. Air handling unit air performance data shall be submitted for review by the Owner's representative.
- B. The manufacturer shall perform a sound test on one selected AHU in accordance with AMCA Standard 300-14, Reverberant Room Method for sound testing of fans, and ANSI/AMCA Standard 210-16. The mechanical engineer shall select the test AHU after review of the submittal.
- C. Provide costs for the following options for client witnessing of pressure and sound testing.
 - 1. In person witnessing. Provide airfare and a hotel room each for one night stay for two representatives of the client.
 - 2. Remote person witnessing. Coordinate a live video call with the client of the pressure and sound testing. The video shall be provided to the client.

1.09 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.

3. Field measurements.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle under the supervision of the owner and in accordance with the manufacturer's Operation & Maintenance manuals
- B. Equipment shall be covered by factory applied shrink wrap material to protect it from accumulating dirt or moisture during transit. The covering shall include a minimum of one zippered opening to allow field access for preventing interior condensation during storage.)

1.11 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents
 1. Filters: One set(s) for each air-handling unit.
 2. Gaskets: One set(s) for each access door.
 3. Fan Belts: One set(s) for each air-handling unit fan.

1.12 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.

PART 2 PRODUCTS

2.01 GENERAL

A. MANUFACTURERS

1. Buffalo Air Handling.
2. Ingenia.
3. TMI Climate Solutions.
4. Trane Custom (Basis of Design).

B. SOURCE QUALITY CONTROL

1. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
2. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
3. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.
4. Steam Coils: Factory tested to 300 psig and to 200 psig under water according to ARI 410 and ASHRAE 33.
5. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.

C. UNIT CASINGS

1. General Fabrication Requirements for Casings:
 - a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
 - b. Casing Joints: Sheet metal screws or pop rivets.
 - c. Sealing: Seal all joints with water-resistant sealant.
 - d. Factory Finish for Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - e. Factory Finish for Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
 - f. Casing Coating: Thermoplastic vinyl
 - g. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
2. Casing Insulation and Adhesive:
 - a. Materials: ASTM C1071, Type I.
 - b. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
 - 1) Liner Adhesive: Comply with {RS#818}, Type I.
 - 2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - 3) Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
 - c. Location and Application: Encased between outside and inside casing.
3. Inspection and Access Panels and Access Doors:
 - a. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Inspection and Access Panels:
 - 1) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - 2) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 3) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - c. Access Doors:
 - 1) Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - 2) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 3) Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
 - 4) Size: At least 18 inches (450 mm) wide by full height of unit casing up to a maximum height of 60 inches (1500 mm).
 - d. Locations and Applications:
 - 1) Fan Section: Inspection and access panels
 - 2) Access Section: Doors.
 - 3) Coil Section: Inspection and access panel.
 - 4) Damper Section: Inspection and access panels.

- 5) Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
 - 6) Mixing Section: Doors.
 - 7) Humidifier Section: Doors.
 - e. Service Light: Vapor proof fixture with 100W equivalent medium base compact fluorescent lamp with switched junction box located outside adjacent to door.
 - 1) Locations: Each section accessed with door
 - 4. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE Std 62.1.
 - 2) Depth: A minimum of 2 inch deep.
 - b. Formed sections.
 - c. Single-wall, galvanized steel sheet.
 - d. Double-wall, galvanized steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - e. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: NPS 1 (DN 25).
 - f. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - g. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
 - 5. Service Platform: Steel wide running entire length of unit and located on service access side, with angle side rails, 4 inch kick plates, and expanded metal floor. Provide platform with a fixed ladder that extends from the top of the side rail to the floor.
 - 6. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
 - a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 20 Section 200548 "Vibration and Seismic Controls" when air-handling unit frame is anchored to building structure.
- D. FAN, DRIVE, AND MOTOR SECTION
 - 1. Fans and Motors: Fan Array System: The fan array system shall consist of multiple, direct driven, arrangement 4 plenum fans AMCA certified for the duty specified, (Class I, II, or III).
 - a. Provide fans with redundant variable speed drives. Variable speed drives shall meet specification section 230934 Variable Frequency Motor Controllers for HVAC.
 - b. All fans shall be selected to deliver the specified airflow quantity at the specified operating total static pressure and specified motor speed.
 - c. The fans shall be selected to operate at a system total static pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed.
 - d. Each fan/motor assembly shall include a minimum 12 airfoil blade aluminum wheel, an 11 gauge, galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge G90 galvanized steel motor support plate and structure.
 - e. The fan air inlet cone, and motor support structure shall be powder coated for corrosion resistance.

- f. All motors are to be standard T-frame pedestal mounted type, (TEFC), selected at the specified operating voltage, rpm, and efficiency as specified or as scheduled elsewhere.
- g. All motors shall include isolated bearings or shaft grounding.
- h. All motors shall be premium efficiency, IEEE inverter ready rated with appropriate winding insulation to meet NEMA MG 00001, part 1 requirements.
- i. The tip speed for each fan shall not exceed 6000 fpm. The fan motor shall operate at a maximum of 80 Hz to achieve scheduled air flow.
- j. Each fan/motor assembly shall be provided with acoustical silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the air handling unit when compared to the same fan array unit without the silencers.
- k. Manufacturers must submit acoustical data for review and approval prior to bid indicating the proposed alternate equipment can meet all specified performance requirements. Proposals submitted which indicate a higher connected fan horsepower than specified or scheduled will not be accepted.
- l. Multiple Fan/Motor VFD Control: Each fan motor shall be individually wired to a control panel with manual motor protection and fusing, powered by a single VFD, as specified elsewhere, for the total connected HP for all fan motors contained in the fan/motor assembly.
- m. Wire sizing shall be determined, and installed in accordance with applicable NEC standards.
- n. Each VFD using a smart power module shall be driven by a "master/slave" control scheme and shall be provided with a redundant VFD in the event of a "master" VFD failure.
- o. The manufacturer shall furnish and install a spare VFD of the same make and model as the VFD(s) being used to power the array of fans or a bank of array fans.
- p. The VFD(s) and one spare VFD shall be furnished by the AHU manufacturer and shall be protected through a hard wired interlock to allow only one VFD to be energized at a time. Circuitries for VFD fault /failures, VFD "master" enable, VFD "slave" enable, and single fan failure or trip conditions are provided by the manufacturer for connecting with the Owner's building automated system (BAS) for control and monitoring purposes.
- q. Connection to the Owner's existing BAS shall be accomplished through hard wire inputs and outputs. Gateway / Interfaces are not allowed. See Fan Array component panel requirements.
- r. The fan/motor assembly shall produce a uniform airflow and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and filter bank face velocity when measured 12 inches from the intake side of the fan array intake plenum wall and at a distance of 48 inches from the discharge side of the fan array intake plenum wall.
- s. Each fan/motor assembly is equipped with a metal grating fan outlet guard.
- t. Each fan/motor assembly shall be independently isolated within a fan tower using 1-inch deflection spring isolators. Isolators shall be mounted in a three point arrangement that provides both vertical and horizontal (thrust) isolation and shall not require field adjustment. Isolation system shall be seismic rated to withstand seismic forces in excess of 2.5G horizontally and vertically. Fan/motor assemblies shall be designed such that no natural frequencies exist within the operating range of the fan, eliminating the need for "lockout" frequency settings in the variable speed drive. Non-isolated fan/motor assemblies are not acceptable.
- u. Each fan array shall be provided with a blank off panel to isolate the inlet side of the fan/motor cube that is on standby or being removed from the fan array. Function is to prevent air bypass through a fan cube when not in operation.

- v. One upstream blank off plate per fan array shall be provided.
 - w. The fan array shall be provided with factory installed airflow measuring devices on one fan. Airflow devices shall be mounted out of the direct air stream so as not to affect system static pressure or sound performance. Sensor accuracy shall be +/- 3%. Performance shall have been verified in an AMCA registered air chamber. Factory installed assembly shall include flow sensors for field connection to a transducer provided by others.
 - x. The manufacturer shall provide a complete spare fan/motor assembly with each one for each type of assembly provided on the project.
 - y. Plug Fan (PF) SWSI Minimum Class II Fans: single width single inlet arrangement 4 as indicated on the Drawings. Fan wheel shall have a minimum of 12 blades made from extruded aluminum as a hollow airfoil in shape, and welded to the center and wheel side plates. The fan Inlet cone shall be made from spun aluminum material. Fan wheel shall be keyed to the shaft.
 - z. Fans shall be both dynamically and statically balanced. Dynamic fan wheel balancing shall be conducted from 16 Hz to 86 Hz to identify and eliminate critical speeds to ensure stable operation through the entire operating range. Each individual fan/motor assembly shall be dynamically balanced to meet AMCA 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.
 - aa. Fans shall be rated in accordance with AMCA 210 for performance and AMCA 300 for sound.
 - bb. Fan motors shall be premium efficiency with a minimum class F insulation and inverter duty rated.
 - cc. Each fan/motor assembly shall be removable through a 30" wide free area access door located on the discharge side of the fan/motor assembly.
 - dd. Bearings shall be antifriction type, either ball or roller, lubricated at the factory with extended lubrication lines where necessary to achieve bearing lubrication or solid silicon nitride (ceramic) bearings.
 - ee. Catalogued type as manufactured by Fafnir, SKF, NTN or Sealmaster; bearings shall be stocked locally.
 - ff. L-10 minimum life of 200,000 hours (direct drive application).
 - gg. Grease fittings for bearings shall be remotely mounted within line of sight of the bearing, where possible. Where line of sight is not feasible, then the fitting shall be mounted with an extended lubrication where it is most easily accessible for service. Stainless steel tubing shall be used for the remote grease fitting. If the motors are equipped with more efficient solid silicon nitride (ceramic) ball bearings, then lubrication lines are not required. Actual location to be provided in submittal for review.
2. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch (25 mm).
- a. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Division 20 Section 200548 "Vibration and Seismic Controls" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.
 - b. Enclosure Type: Totally enclosed, fan cooled.
 - c. NEMA Premium (TM) efficient motors as defined in NEMA MG 00001.
 - d. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

- f. Mount unit-mounted disconnect switches on exterior of unit.
 - 3. Variable Frequency Controllers:
 - a. Refer to Division 20 Section 200514 "Variable Frequency Drives" for requirements.
- E. COIL SECTION
 - 1. General Requirements for Coil Section:
 - a. Comply with ARI 410.
 - b. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - c. Coils shall not act as structural component of unit.
 - d. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Division 20 Section 200548 "Vibration and Seismic Controls" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.
 - 2. Refer to Division 23 Section 238216 "Air Coils and Drain Pans" for requirements.
- F. AIR FILTRATION SECTION
 - 1. General Requirements for Air Filtration Section:
 - a. Comply with NFPA 90A .
 - b. Provide minimum arrestance according to ASHRAE Std 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE Std 52.2.
 - c. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - 2. Refer to Division 23 Section 23 41 00 "Particulate Air Filtration" for requirements.
- G. DAMPERS
 - 1. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm (10-m/s) face velocity through damper and 4-inch wg (1000-Pa) pressure differential.
 - 2. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with cadmium-plated steel operating rods rotating in stainless-steel sleeve bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch w.g. and 9 cfm/sq. ft. at 4-inch w.g..
 - 3. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
 - 4. Combination Filter and Mixing Section:
 - a. Cabinet support members shall hold 2 inch thick, pleated, flat, permanent or throwaway filters.
 - b. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.
- H. HUMIDIFIERS
 - 1. Refer to Division 23 Section 238413 "Humidifiers" for requirements.
- I. AIR BLENDER
 - 1. Provide air blenders of size, pressure drop and capacity as indicated on drawings.

2. Unit casing shall be constructed to meet the applicable requirements for air handling units. Casing size shall exactly match the sizes of the upstream and downstream air handling unit modules.
3. The blender shall be constructed of minimum 0.080" thick aluminum.
4. The blender shall be capable of mixing two airstreams to within a +/-6 degree F. tolerance of the theoretical mixed air temperature when mixing 50% outside air with 50% return air at 60 degree F. inlet temperature differential, and to within a +/-4.5 deg. F tolerance when mixing 30% outside air with 70% return air at 60 degree F. inlet temperature differential. The blender's performance range shall be from 600 FPM through 2500 FPM (blender velocity) with no loss in mixing performance.
5. The blender shall provide a uniform velocity profile at downstream components such as filters, coils, etc.
6. Blenders shall be installed per the manufacturer's instructions, including but not limited to the provision for required upstream and downstream mixing distances.
7. Manufacturers:
 - a. Blender Products, Inc.

PART 3 EXECUTION

3.01 APPLICATION

3.02 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

3.04 INSTALLATION

- A. Equipment Mounting:
 1. Comply with requirements for vibration isolation and seismic control devices specified in Division 20 Section 200548"Vibration and Seismic Controls."
 2. Comply with requirements for vibration isolation devices specified in Division 20 Section 200548"Vibration Controls."
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.05 CONNECTIONS

A. Piping Connections

1. Install piping adjacent to air-handling unit to allow service and maintenance.
2. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
3. Connect condensate drain pans using NPS 1-1/4 (DN 32), {RS#591}, Type M ({RS#592}, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
4. Hot- and Chilled-Water Piping: Comply with applicable requirements in Division 23 Section 232113 "Hydronic Piping" and Division 23 Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
5. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section 232213 "Steam and Condensate Heating Piping" and Division 23 Section 232216 "Steam and Condensate Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.

B. Duct Connections

1. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section 233300 "Air Duct Accessories."

C. Electrical Connections

D. Control Connections

3.06 FIELD QUALITY CONTROL

- #### A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch w.g. or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- #### C. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

- #### D. Prepare test and inspection reports.

3.07 START UP SERVICE

- #### A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.

3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 7. Comb coil fins for parallel orientation.
 8. Install new, clean filters.
 9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.08 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Division 20 Section 200593 "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.09 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

SECTION 238216

AIR COILS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic coils.
- B. Steam coils.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 230719 - HVAC Piping Insulation.
- B. Section 232114 - Hydronic Specialties.
- C. Section 232214 - Steam and Condensate Heating Specialties.
- D. Section 233100 - HVAC Ducts and Casings: Installation of duct coils.
- E. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.04 REFERENCE STANDARDS

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. ASHRAE 33 - Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils.
- C. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- E. ASTM B743 - Standard Specification for Seamless Copper Tube in Coils.
- F. UL 1995 - Heating and Cooling Equipment.

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
 - 2. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- B. Closeout Submittals

1. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 WARRANTIES

- A. Provide five year manufacturer warranty for coils.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 PRODUCTS

2.01 HYDRONIC COILS

- A. Manufacturers:
 1. Aerofin.
 2. Heatcraft Worldwide Refrigeration.
 3. Trane.
- B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- C. Minimum Working-Pressure/Temperature Ratings: 200 psig , 325 deg F .
- D. Source Quality Control: Factory tested to 300 psig.
- E. Tubes: ASTM B743 copper, minimum 0.020 inch thick.
- F. Tubes: ASTM B743 copper, minimum 0.035 inch (0.889 mm) thick.
- G. Fins: Aluminum, minimum 0.010 inch thick.
- H. Headers: Seamless copper tube with brazed joints, prime coated Cast iron with drain and air vent tapings.
- I. Freeze Protection Low Temperature Pressure Relief Valve: coils shall be provided with factory installed temperature and pressure valve. Valve shall be installed on a header on the end of the coil. Valve shall be set to open when the coil's temperature drops below 35 degress Fahrenheit or the internal pressure in the coil rises above 200 psig. Relief valve shall discharge into pan under coil.
- J. Frames, Chilled Water Coils: ASTM A666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in mounting.

2.02 STEAM COILS

- A. Manufacturers:
 - 1. Aerofin.
 - 2. Heatcraft Worldwide Refrigeration.
 - 3. Trane.
- B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- C. Minimum Working-Pressure/Temperature Ratings: 100 psig , 400 deg F .
- D. Source Quality Control: Factory tested to 300 psig .
- E. Tubes: ASTM B743 copper, minimum 0.025 inch (0.635 mm) thick.
- F. Fins: Aluminum, minimum 0.010 inch thick.
- G. Headers: Cast iron with drain and air vent tappings Cast iron with cleaning plugs, and drain and air vent tappings.
- H. Tube Type: Single or distributing as indicated.
- I. Frames: Galvanized-steel channel frame, minimum 0.052 inch 0.064 inch (1.6 mm) thick for slip-in mounting.
- J. Frames: ASTM A666, Type 304 stainless steel, minimum 0.0625 inch thick for slip-in mounting.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Install stainless-steel drain pan under each cooling coil.
 - 1. Construct drain pans with connection for drain; insulated and complying with ASHRAE Std 62.1.
 - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - 3. Extend drain pan upstream and downstream from coil face.
 - 4. Extend drain pan under coil headers and exposed supply piping.
- D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
- E. Straighten bent fins on air coils.

- F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.03 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section 230900 "Instrumentation and Control for HVAC," and other piping specialties are specified in Division 23 Section 232113 "Hydronic Piping."
- D. Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section 230900 Section "Instrumentation and Control for HVAC," and other piping specialties are specified in Division 23 Section 232213 Section "Steam and Condensate Heating Piping."
- E. Ground equipment according to Division 26 Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Division 26 Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections with the assistance of a factor-authorized service representative:
 - 1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Prepare test and inspection reports.

SECTION 238413

HUMIDIFIERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Steam Dispersion - Multiple Tube Unit

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 230719 - HVAC Piping Insulation.

1.04 REFERENCE STANDARDS

- A. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality.
- B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.
- C. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide catalog sheets indicating general assembly, dimensions, weights, materials, and certified performance ratings.
 - 2. Shop Drawings: Indicate general assembly, dimensions, weights, and materials.
 - 3. Manufacturer's Instructions: Indicate recommended installation instructions.
 - 4. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- B. Operation and Maintenance Materials
 - 1. Operation Data: Include assembly instructions, float adjustment, bleed rates, and electrical requirements.
 - 2. Maintenance Data: Include instructions for lubrication, filter replacement, cleaning, and spare parts lists.

1.06 WARRANTIES

- A. Provide five year manufacturer warranty for units.

1.07 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 STEAM DISPERSION - MULTIPLE TUBE UNIT

- A. Manufacturers:
 - 1. Armstrong International.
 - 2. Condair (Nortec).
 - 3. DRI-STEEM.
- B. General
 - 1. Multi-purpose humidifier dispersion panel for both pressurized and evaporative atmospheric steam applications in AHUs or ducts
 - 2. Humidifier panel consisting of steam supply header / separator, condensate collection header and bank of steam dispersion tubes and contained within a casing with inlet and outlet flanges, suitable for duct mounting and / or installation in air handling casings.
 - 3. Designed for rapid, drip-free absorption, steam does not condense on downstream devices
- C. Manifold: ASTM A666, Type 304 stainless steel, insulated with 1/2-inch fiberglass and extending the full width of duct or plenum with mounting brackets at ends.
- D. Steam Separator: Cast iron ASTM A666, Type 304 stainless steel with separate humidifier control valve.
- E. Humidifier Control Valve:
 - 1. Actuator: As specified in Division 23 Section 230900 "Instrumentation and Control for HVAC."
- F. Steam Trap: Inverted-bucket type, sized for a minimum of 3 times the maximum rated condensate flow of humidifier at 1/2-psig inlet pressure.
- G. Accessories:
 - 1. Duct-mounting, high-limit humidistat.
 - 2. Aquastat mounted on steam condensate return piping to prevent cold operation of humidifier.
 - 3. In-line strainer.
 - 4. Airflow switch for preventing humidifier operation without airflow.
- H. Horizontal Dispersion Tubes: All piping shall be on one side of the duct or air handling unit.
- I. All humidifier components shall be constructed for use with de-ionized or reverse osmosis water.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE Std 62.1.
- B. Seal humidifier manifold duct or plenum penetrations with flange.
- C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- D. Install manifold supply piping pitched to drain condensate back to humidifier.
- E. Install drip leg upstream from steam trap a minimum of 12 inches tall for proper operation of trap.
- F. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Division 20 Section 200548 "Vibration Controls."
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Division 20 Section 200548 "Vibration and Seismic Controls."
- G. Install all manufacturer-furnished accessories in accordance with manufacturer's written installation instructions.

3.03 CONNECTIONS

- A. Piping Connections
 - 1. Piping installation requirements are specified in other Division 20 and Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - a. Install piping adjacent to humidifiers to allow service and maintenance.
 - b. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.
 - c. Install piping from safety relief valves to nearest floor drain.
- B. Control Connections
 - 1. Connect control wiring between humidity sensors, high-limit humidity sensors, and DDC control system.
 - 2. Connect control wiring between humidistats and controlled devices.
 - 3. Connect control wiring according to Division 26 Section 260523 "Control-Voltage Electrical Power Cables."

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Humidifier will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.05 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units and system.

SECTION 260000 - GENERAL ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Definitions
 - 2. Scope of Work
 - 3. Work Not Included
 - 4. Intent of Drawings
 - 5. Pre-Bid Site Visit
 - 6. General Standards of Materials
 - 7. Products and Substitutions
 - 8. Applicable Codes
 - 9. Maintainable Assets
 - 10. Guarantees and Certificates
 - 11. Quiet Operation and Vibration Control
 - 12. Temporary Shutdown of Existing Systems
 - 13. Coordination
 - 14. Shop Drawings, Product Data, and Samples
 - 15. Owner Instruction

1.3 DEFINITIONS

- A. Specific terminology, as used herein, shall have the following meanings:
 - 1. "Finished Space" ...Space other than mechanical rooms, electrical rooms, furred spaces, pipe chases, unheated spaces immediately below roof, space above ceilings, unexcavated spaces, crawl spaces, tunnels, and interstitial spaces.
 - 2. "Conditioned" ...Spaces directly provided with heating and cooling.
 - 3. "Unconditioned" ...Spaces without heating or cooling including ceiling plenums.
 - 4. "Indoors" ...Located inside the exterior walls and roof of the building.
 - 5. "Outdoors" ...Located outside the exterior walls and roof of the building.

1.4 SCOPE OF WORK

- A. The scope of the work included under Division 26 of the specifications shall include complete systems as shown in the Contract Documents and specified herein. Any work reasonably inferable or required to result in a complete installation or the intended operation and performance of the systems, shall be included in the Base Bid except where there is specific reference to exclusion and incorporation in other quotations.
- B. A brief written Scope of Work appears in Division 01.

- C. Without limiting or restricting the volume of work and solely for convenience, the work to be performed will, in general, comprise of the following:
1. Demolition.
 2. Temporary service lighting and power.
 3. Grounding
 4. Equipotential grounding system.
 5. Power and/or lighting panelboards.
 6. Short circuit analysis and ground fault coordination study.
 7. Transient voltage surge suppressors.
 8. Feeders.
 9. Branch circuits.
 10. Power wiring to motors.
 11. Installation of electric powered equipment supplied by others.
 12. Wiring of equipment furnished by others and final connections to same.
 13. Installation of Individually mounted starters.
 14. Installation of Adjustable Frequency Drives (AFD's) and Harmonic Mitigation Filters.
 15. Lighting fixtures and controls.
 16. Low voltage switching systems.
 17. Telephone system.
 18. Data system.
 19. Fire alarm system.
 20. Sound system.
 21. Nurse call system.
 22. Intercom system.
- D. Items of labor, material, and equipment not specified in detail or shown on drawings, but incidental to or necessary for the complete installation and proper operation of the several branches of work and described herein, or reasonably implied in connection herewith, shall be furnished as if called for in detail by the specifications or drawings. This includes electrical work associated with mechanical and plumbing work whether indicated on electrical drawings or not.

1.5 WORK NOT INCLUDED

- A. The following items of Electrical Construction are not included in this contract:
1. Certain low voltage wiring of mechanical equipment shall be done by the respective Contractor.
 2. Certain motors and equipment, such as pumps, fans, etc., shall be provided by others, complete with motor and built-in or separate controllers as covered by such contracts. The extent of work required by this Contractor in connection with the provisions of this equipment is described hereinafter under "Electrical Powered Equipment."
 3. Motors connected to driven equipment shall be set by respective Contractor furnishing same.
 4. Certain line voltage electrical apparatus such as switches, starters, controllers, transformers, etc., furnished by others shall be delivered to the curb by the Contractor furnishing the equipment, unless specifically noted otherwise. Unload and transport to installation location.
 5. Electric heating equipment.

1.6 INTENT OF DRAWINGS

- A. Provide complete and functional systems for the project. The systems shall conform to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform with accepted trade practices. The drawings and specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this contractor's work.
- B. Unless specifically dimensioned, the work shown on the drawings is diagrammatic, and is intended only to show general arrangement. Do not scale the drawings. Because of the scale of the drawings, it is not possible to indicate offsets, fittings, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Check and verify dimensions and existing conditions at the site. Install systems in such a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items required to meet the project conditions without additional cost to the owner.
 - 1. These documents may not explicitly disclose final details required for a complete systems installation; however, contractors shall possess the expertise to include the necessary appointments of complete operating systems.
 - 2. Bidders shall have sufficient expertise in this type of construction to realize the extent of the work required.

1.7 GENERAL STANDARDS OF MATERIALS

- A. The specifications and drawings establish the standards of quality required, either by description or by references, to brand name, name of manufacturers and/or manufacturer's model number.
- B. Equipment and materials, unless otherwise noted, shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five years.
- C. Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts and components.
- D. Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.
- E. With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.

1.8 PRODUCTS AND SUBSTITUTIONS

- A. Where a specific manufacturer's product is specified, the Contract Amount shall be based on that product only. Any substitutions from the specified product shall be offered as a Substitution Request. Refer to Division 01 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.
- B. Where several manufacturer's products are specified, the Contract Amount shall be based upon the specified products only. Any substitutions from the specified products shall be offered as a Substitution Request. Refer to Division 01 for requirements. Substitutions shall not be permitted after the bidding phase without a Substitution Request Form included with the bid.
- C. Where only one manufacturer's product is specified, the associated systems have been designed on the basis of that product. Where several manufacturer's products are specified, the associated systems have been designed on the basis of the first-named manufacturer's product. When products other than those used as the basis of design are provided, the contractor shall pay all additional costs related to submissions review, redesign, and system and/or structure modifications necessary to use that product. Such additional costs shall be identified at the time such substitutions are proposed.
- D. It is the intent of these specifications that service organizations such as testing agencies follow the above substitution procedures.

1.9 APPLICABLE CODES

- A. Materials furnished and work installed shall comply with applicable codes listed in Division 01, with the requirements of the local utility companies, and with the requirements of governmental departments or authorities having jurisdiction.

1.10 GUARANTEES AND CERTIFICATES

- A. The contractor and equipment manufacturers shall jointly guarantee all wiring and equipment to be free of defects in workmanship and material for a period of one year from the date of final acceptance, unless otherwise noted.
- B. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract resulting from same, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated guarantee periods.
 - 1. Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of the equipment for temporary conditioning, testing, etc., prior to occupancy will not be considered part of the warranty period.

1.11 QUIET OPERATION AND VIBRATION CONTROL

- A. Equipment and associated items shall operate under conditions of load without sound or vibration deemed objectionable by the Architect. In the case of moving equipment, sound or vibration noticeable outside of the room in which it is installed, or noticeable within the room in which it is installed, shall be deemed objectionable. Sound or vibration deemed objectionable shall be corrected in an approved manner at no extra cost to the Owner. Vibration control shall be provided by means of approved vibration isolators and installed in accordance with the isolator manufacturer's recommendations.
- B. The sound pressure levels around mechanical and electrical equipment (fans, pumps, motors, etc.) in equipment spaces shall not exceed 85 dBA at any point three (3) feet from the equipment, with all equipment in the room operating. The sound criteria applies to the complete range of each piece of equipment.

1.12 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

- A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing systems. Some temporary shutdown of existing systems may be required to complete the work.
- B. Submit to the Owner in writing for approval, proposed date schedule, time, and duration of necessary temporary shutdowns of existing systems. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner. The Owner reserves the right to cancel shutdowns at any time prior to the shutdowns. To ensure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections. No additional charges shall be allowed for Owner-canceled shutdowns that must be rescheduled.
- C. Shutdowns must be performed by the Owner. Do not shut-down any system. The Owner reserves the right to require a walk-through of any shutdown prior to the shutdown. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors.

1.13 COORDINATION

- A. Coordinate and furnish in writing to the Architect information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.
- B. Coordination drawings shall be prepared as defined in Division 1. No installation of permanent systems shall proceed until the coordination drawings are reviewed by the Architect. No extra charges shall be allowed for changes required to accommodate installation of systems provided under other divisions of this contract.
- C. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
- D. When work is installed without proper coordination, changes to this work deemed necessary by the Architect shall be made to correct the conditions without extra cost to the Owner.

- E. The value of the coordination drawings shall be identified as a line item in the Schedule of Values. If the coordination drawings are not submitted as required, their value shall be credited to the Owner in accordance with the provisions of Article 7 of the General Conditions. The value of coordination drawings shall be a minimum of two (2.0) percent of this Contract Amount.

1.14 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- A. Shop drawings, product data, and samples shall be submitted in accordance with the provisions of Division 01.
- B. The following shall be submitted by the Contractor for review:
 - 1. Product data for system components and materials (including construction standards).
- C. The value of shop drawings, product data and samples shall be identified as a line item in the Schedule of Values. If the shop drawings, product data and samples are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of these items shall be a minimum of one (1.0) percent of this Contract Amount.

1.15 OWNER INSTRUCTION

- A. After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be 10 man hours. The instruction period shall be broken into segments at the discretion of the Owner.
 - 1. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one (1) week prior to conducting same.
 - 2. Forward to the Architect the signatures of all those present for the instruction periods.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 260000

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation
 - 2. Sleeves for raceways and cables
 - 3. Sleeve seals
 - 4. Grout
 - 5. Common electrical installation requirements
 - 6. Seismic Restraint
 - 7. Demolition
 - 8. Waterproofing
 - 9. Cutting and Patching
 - 10. Access Panels
 - 11. Protection of Floors
 - 12. Painting
 - 13. Equipment Foundations, Supports, Piers and Attachments
 - 14. Equipment Guards and Rails
 - 15. Cleaning, Protecting and Adjusting
 - 16. Welding

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. Wiring: Cable and/or wire installed in Raceway.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 SEISMIC RESTRAINT

- A. Provide seismic restraints for all conduit, equipment, systems, etc. as required by the International Building Code, Chapter 16 as identified herein. Confirm Use Group and Seismic Design Category with Structural Engineer prior to proceeding with any work.

1.6 DEMOLITION

- A. Review the demolition drawings, to determine the affected areas of the existing structure. Remove electrical appurtenances in the affected areas not to be reused including wire, conduit, switches, outlets, light fixtures, and fittings. If any existing electrical items are to be removed, either patch area as required or provide a blank cover plate over boxes to remain.
- B. Any conduit or wiring that is not to be permanently removed or that feeds other remaining sections of the building shall be relocated as necessary and rerouted and reconnected as required.
- C. Items removed above shall become the property of the Owner unless otherwise noted. If the Owner has no use for any of the items, remove them from the site.
- D. Maintain the continuity of any present circuits that may be interrupted by these alterations even though they may not be indicated on the drawings. Furnish the labor and necessary materials required to restore the circuit.
- E. Where circuits are looped and outlets are removed, make adjustments and connections to restore the circuits.
- F. Participate in a recycling and disposal program for fluorescent lamps containing mercury and PCB ballasts. Pay all fees associated with recycling.

1. Lamps

- a. Recycle fluorescent lamps intact, place into lamp boxes, and mark box "for recycling."
- b. Materials shall be transported to a state and federally approved recycling facility. Provide documentation that materials were recycled in accordance with State and Federal laws.

2. Ballasts

- a. Where PCB ballasts are identified, remove ballasts from fixture and place in a DOT1AZ shippable, removable head, 55 gallon steel drum. Date and label drum as "PCB Contaminated." Weight of drum shall not exceed 600 pounds.
 - b. Arrange for drums to be delivered to a state and federally approved recycling facility. Provide documentation that the materials were recycled in accordance with State and Federal laws.
- G. Where existing electrical devices and items are to be removed, ceilings, floors, wall partitions, etc., are to be patched by the Electrical Contractor. Particular attention must be paid to associated construction types and methods of affected areas. All patching for these areas is to match the existing and intended finishes for that area no matter what the type of construction. Coordinate all patching work fully with the Architect and General Contractor. Blank cover plates over demolished items will not be acceptable.

1.7 WATERPROOFING

- A. Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect prior to performing the work. Furnish necessary sleeves, caulking and flashing required to make openings absolutely watertight.

1.8 WEATHERPROOFING LOCATIONS (WP)

- A. Electrical apparatus, such as outlet boxes, switches, thermal switches or manual starters, disconnect switches, combination switches and starters, motor control centers, and motor starters shall be weatherproof gasketed type, NEMA Types 3 or 4 in the following instances:
 - 1. On surface of exterior face of building, including areas where not under canopies, cast boxes with threaded hubs must be used and under canopies steel boxes with gasket connections to devices.
 - 2. In any areas where specifically noted "WP" or required by the NEC or Electrical Regulations mentioned herein.
 - 3. Within air conditioning enclosures.
 - 4. In underground splice boxes.
 - 5. On building roof.

1.9 CUTTING AND PATCHING

- A. Provide cutting and patching necessary to install the work specified herein. Patching shall match adjacent surfaces. Refer to Division 01, Cutting and Patching for specific directions.
- B. No structural members shall be cut without prior approval of the Architect; such cutting shall be done in a manner directed by him.
- C. Provide ceiling removal and replacement where work above ceilings is required. Replace ceiling components damaged in the process.
- D. Provide patching where electrical devices are removed from walls, ceilings or floors.
- E. Cutting and patching shall be performed only by tradesmen familiar with the construction involved.

1.10 ACCESSIBILITY OF EQUIPMENT

- A. Coordinate to ensure the sufficiency of the size of shafts, and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.
- B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights, curtain tracks, speakers, and medical gas tracks. Equipment requiring access shall include, but is not necessarily limited to, motors, junction boxes, fire dampers, controllers, switchgear, etc.
- C. Indicate the locations of access doors for each concealed device, concealed behind finished construction and requiring service on the coordination drawings. Equipment below floor slab or finished grade shall be indicated on the coordinating drawings.

- D. Furnish access doors under this division for installation by General Contractor. Coordinate during bidding phase with General Contractor. Locations of access doors in finished construction shall be submitted in sufficient time to be installed in the normal course of the work.

1. Manufacturers: Subject to compliance with requirements, furnish access doors by one of the following:
 - a. Bar-Co., Inc.
 - b. J. L. Industries
 - c. Karp Associates, Inc.
 - d. Nystrom, Inc.
2. Materials and Fabrication:
 - a. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts and ready for installation.
 - b. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.
 - c. Frames: Fabricate from 16-gauge steel.
 - 1) Fabricate frame with exposed flange nominal 1 inch wide around perimeter of frame for units installed in the following construction:
 - a) Exposed Masonry
 - 2) For gypsum drywall or veneer gypsum plaster, furnish perforated frames with drywall bead.
 - 3) For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
 - 4) For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
 - d. Flush Panel Doors: Fabricate from not less than 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees. Finish with manufacturer's factory-applied prime paint.
 - 1) For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.
 - e. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

1.11 PROTECTION OF FLOORS

- A. Protect existing flooring from damage during the construction period. Provide plywood or similar material under equipment or materials stored on floors, and in areas where construction may damage the floor surfaces. Floor surfaces (including sealer) damaged during the construction shall be replaced at the cost of the Contractor at fault.

1.12 PROTECTION OF SERVICES

- A. Repair, replace and maintain in service any new or existing utilities, facilities or services (underground, overground, interior or exterior) damaged, broken or otherwise rendered inoperative during construction. The method used in repairing, replacing or maintaining the services shall be approved by the Owner and Architect.

1.13 PAINTING

- A. Painting requirements of this section shall conform to Section 099123 – Painting.
- B. Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.
- C. Electrical motors, pump casings and other similar items shall be provided with three (3) coats of machinery enamel at the factory, and shall be carefully cleaned, rubbed down and oiled after installation.
- D. Provide prime coat painting for the following:
 - 1. Indoor miscellaneous steel and iron provided under this Division of the specifications.
 - 2. Indoor hangers and supports provided under this Division of the specifications.

1.14 EQUIPMENT FOUNDATIONS, SUPPORTS, PIERS AND ATTACHMENTS

- A. Provide concrete pads for all floor-mounted electrical equipment, unless indicated otherwise. Equipment shall include, but is not limited to, base mounted transformers, switchboards, switchgear, rotating equipment and similar.
- B. Provide concrete bases for site equipment as specified and shown on the drawings. Equipment shall include, but is not limited to, pad mounted transformers, switchgear, generators, lighting poles and similar.
- C. Provide necessary foundations, auxiliary steel, supports, pads, bases and piers required for equipment specified in this division; submit drawings in accordance with Shop Drawing Submittal requirements prior to the purchase, fabrication or construction of same. Submit detailed shop drawing on all concrete pads showing plan view, elevation and special details as required. Include locations and details of anchor bolts, dimensions, reinforcing and doweling.
- D. Concrete Work
 - 1. Construction of foundations, supports, and pads where mounted on the floor, shall be of the same materials (where it exceeds the following specifications) and same quality of finish as the adjacent and surrounding floor material.
 - 2. Concrete shall have a compressive strength of 3,000 psi minimum at 28 days. Placing of reinforcing steel and concrete shall be done according to recommendations of the American Concrete Institute and American Society of Testing Materials, Specifications, applicable to this work.
 - 3. Concrete pad for electrical equipment shall be 4 inches above finished floor or 6 inches above finished grade, unless indicated otherwise.

4. Pads shall extend 4 inches beyond equipment base in each direction and shall have sloped bevels on all horizontal and vertical edges.
5. Anchor equipment pads to the floor in accordance with latest building codes seismic requirements.
6. Form work shall be of sufficient strength to maintain desired shape during pouring of concrete and tight enough to prevent leakage of the grout through joints.

E. Anchor Bolts

1. Provide and set in place at the time of pouring concrete, all necessary anchor bolts. Anchor bolts shall be hook type, of proper size and length to suit the equipment. Anchor bolts shall be set in pipe sleeves of approximately twice the bolt diameter and one-half the embedded length of the bolt. Assume full responsibility for proper emplacement of the bolts.
2. Drop-in wedge anchor bolts or self-drilling anchors may be used in place of hook bolts. Minimum embedment in concrete of wedge anchor bolts shall be in accordance with manufacturer's instructions. Wedge anchor bolts shall be manufactured by Phillips Drill Company, USM Corporation or equal. Self-drilling anchors shall be manufactured by Phillips Drill Company or equal.
3. Powder actuated industrial fasteners are not permitted.

F. Equipment shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect, not strong enough shall be replaced as directed, with no additional cost to the Owner.

G. After equipment is set in place and bolted down, any space between equipment base and concrete pad shall be completely filled with non-shrink grout as specified in below.

1.15 CLEANING, PROTECTING AND ADJUSTING

- A. General cleaning requirements are specified in Division 01.
- B. Materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on site in open or unprotected areas, equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
- C. Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Architect or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.
- D. During the construction period, protect equipment from damage and dirt.
- E. Vacuum cabinets, switchboards, switchgear, lighting and power panels, etc., after completion of work.
- F. Adjusting
1. After the entire installation has been completed, make required adjustments to balance panelboards and adjust lighting fixtures until performance requirements are met.

1.16 SPECIAL TOOLS

- A. Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Coordinate all locations of equipment, prior to rough-in, since final locations may differ from that indicated on the drawings. Obtain detailed and specific information regarding the installation locations. Outlets, equipment or wiring improperly placed because of failure to obtain this information shall be relocated and reinstalled without additional expense to the Owner. Determine the actual direction of door swings, so that local switches and other controls shall be installed at the latch side of doors, unless otherwise noted. Improperly located switches shall be relocated without additional expense to the Owner.
- F. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of outlets or equipment without written consent of the Architect and Owner.
- G. Unless otherwise mentioned or indicated, mounting heights of outlets are shown on the drawings or in the specification. Dimensions given shall be considered to be from center of outlet to finished floor.
- H. Coordinate the location and elevation of all electrical devices and fixtures with the architectural interior elevation plan and reflective ceiling plan prior to installation.
- I. Properly coordinate the rough-in of the electrical conduit and equipment under this contract. Modify as required for coordination during the construction period.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain.
 - 2. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Through-Penetration Firestop System."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop System."

3.5 DUST, DIRT AND NOISE

- A. Carry out new work and make changes, relocations, and installations with a minimum of noise. Site areas and new equipment, floors and walls, shall be adequately protected from dust and dirt caused by the work. Protection shall include suitable temporary barriers or coverings. The exterior and interior premises of each building shall be kept clean as possible during construction. Damages to surfaces or equipment as a result of negligence shall be re-placed or corrected as required.

3.6 ENVIRONMENTAL AIR PLENUMS

- A. In spaces over hung ceiling which are used for environmental air handling purposes as defined by Article 300.22C of the National Electric Code, power data and communications cable must be in conduit or of the type cable rated for air plenum use. Cable type and/or raceway is generally indicated on the electrical drawings and specifications although the Contractor shall be responsible to clearly define ceiling space used for environmental air purposes.

3.7 SPECIAL REQUIREMENTS FOR HEALTH CARE FACILITIES

- A. Electrical construction shall comply with the provisions of Article 517, Health Care Facilities, of the NEC.

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS & CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.
- B. Related Sections include the following:
 - 1. Division 26 Section "Common Work Results for Electrical".
 - 2. Division 26 Section "Raceway and Boxes for Electrical Systems" for cable-in-conduit for exterior branch circuits.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.5 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. American Insulated Wire Corp.; a Leviton Company.
 - 2. General Cable Corporation.
 - 3. Cablec Continental Cable Company.
 - 4. Southwire Company.
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types [THHN/THWN-2] [XHHW].
- D. Multiconductor Cable (where permitted): Comply with NEMA WC 70 for metal-clad cable, Type MC, health care facilities cable, Type HCF, with ground wire.
- E. Wiring on load side of isolation panel shall have insulation with a dielectric constant less than 3.5 and insulation resistance greater than 6,100 megohm/meter at 16 degrees C. Do not use wire pulling lubricants or soaps when pulling these conductors.

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Thomas & Betts Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper: Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Wire smaller than No. 12 AWG shall not be used for lighting or power circuits.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway, Metal-clad cable, Type MC, Health Care Facilities cable, Type HCF.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Accessible Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway, Metal-clad cable, Type MC, Health Care Facilities cable, Type HCF.
- F. Branch Circuits Concealed in Concrete Masonry, Above Inaccessible Ceilings, Below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- G. Class 1 Control Circuits: Type THHN/THWN-2, in raceway.
- H. Class 2 Control Circuits: Type THHN/THWN-2, in raceway.

3.3 HEALTH CARE FACILITIES CABLE

- A. Material
 - 1. Armored cable rated for health care facilities (HCF) shall be a factory assembly of insulated conductors enclosed in a flexible galvanized metallic enclosure.
 - 2. Conductors within HCF cable shall be 90C rated Type THHN including an individual full-sized green insulated ground conductor.
 - 3. All wire shall be stranded, unless otherwise noted.
- B. Manufacturers
 - 1. AFC/A Nortek Company
 - 2. Southwire Company
- C. Permitted Uses
 - 1. From building wiring junction box located in each room to each light fixture in lengths not to exceed 6 feet.
 - 2. Installed in walls between devices.
 - 3. Branch circuits back to panelboards must be installed in EMT conduit to maintain redundant ground fault current path.
- D. Not Permitted
 - 1. Healthcare facilities cable shall not be used for homeruns to panelboards or for normal/emergency circuits.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- G. Metal Clad Cabling shall be secured every six feet and within 12 inches of every box or termination as required by code. Installation of metal clad cabling shall be done in a neat and workmanlike manner and follow or be perpendicular to building lines.

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.
- D. Copper conductors #10 AWG and smaller shall be terminated and spliced with wire nut connectors. The nylon self-insulated type shall be used to isolate the termination from other metal parts and equipment.
- E. Copper conductors #8 AWG and larger shall be terminated, spliced, and tapped with color-keyed compression connectors. The manufacturers recommended tools and dies shall be used.
- F. Copper cable lug connections #8 and larger to copper bus bar mains and branches shall use copper solderless connectors having either 2-bolt cast copper clamps or compression connectors, with manufacturer's recommended hexagonal dies and hydraulic compression tools.

- G. Where terminal strips are indicated, provide strips having each terminal equipped with two clamp type pressure lugs or two washer bead binding screws. Use terminal strips having 20 ampere minimum terminal ratings. Provide a white marking strip along the center line of each row of terminals for identification. Use strips having plastic barriers between adjacent terminals. Provide terminal quantities indicated. If quantity is not indicated, provide one terminal for each conductor entering enclosure plus 20 percent spare terminals. Type or otherwise mark the identification strip to identify each connected circuit. Relate identification to wiring diagrams, panel schedules and other terminals in a logical manner, where specific identification requirements are not indicated. Under no circumstances shall more than one wire be terminated under each terminal. Use only approved type jumper to mechanically connect terminals to each other.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test, for compliance with requirements.
 - a. 600 volt feeders
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- D. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

- E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Grounding arrangements and connections for separately derived systems.
 - 2. Grounding for sensitive electronic equipment.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 by 36 inches (6 by 50 by 900mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus on insulated spacers 3 inch (75 mm), minimum, from wall 8 inches (200 mm) above finished floor, unless otherwise indicated.
 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- D. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 2. Underground Connections: Exothermic welded connectors, except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Exothermic welded connectors.
4. Connections to Structural Steel: Exothermic welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Provide insulated equipment grounding conductors with all feeders and branch circuits.
- B. Provide insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Metal-clad cable runs.
 8. Computer and Rack-Mounted Electronic Equipment Circuits: Provide insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
 9. Medical Equipment Circuits: Provide insulated equipment grounding conductor in circuits supplying x-ray equipment.
- C. Air-Duct Equipment Circuits: Provide insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Isolated Grounding Receptacle Circuits: Provide an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-36-inch (6-by-50-by-900-mm) grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- B. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Nonmetallic slotted channel systems. Include Product Data for components.
 - 4. Equipment supports.

- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
 - 9. Items mounted to walls with steel studs space 16" on center: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices shall be secured to steel stud framing, blocking and/or structural elements within the wall.

- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Cold Formed Metal Framing" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. RSC: Rigid galvanized steel conduit.
- G. LFMC: Liquidtight flexible metal conduit.
- H. LFNC: Liquidtight flexible nonmetallic conduit.
- I. NBR: Acrylonitrile-butadiene rubber.
- J. RNC: Rigid nonmetallic conduit.
- K. SMR: Surface metal raceway.
- L. HDPE: High Density Polyethylene

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members in the paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. AFC Cable Systems, Inc.
 2. Alflec Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.
 7. Maverick Tube Corporation.
 8. O-Z Gedney; a unit of General Signal.
 9. Wheatland Tube Company.
- B. Rigid Galvanized Steel Conduit: ANSI C80.1 and UL 6.
- C. EMT: ANSI C80.3.
 1. Color Coded EMT: Hot-galvanized EMT conduit with a factory applied top coat available in seven colors, ANSI C80.3.
- D. FMC: Zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 2. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
- G. Joint Compound for Rigid Galvanized Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Screw-cover type or Flanged-and-gasketed type.
- F. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Thomas & Betts Corporation.
 - b. Wiremold Company (The); Electrical Sales Division.
 - c. Hubbell Wiring Devices.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell Company.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet Division.
 - 10. Spring City Electrical Manufacturing Company.

11. Thomas & Betts Corporation.
 12. Walker Systems, Inc.; Wiremold Company (The).
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
 14. Carlon Electrical Products.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.
- D. Metal Floor Boxes: Sheet metal or Cast or sheet metal, fully adjustable, rectangular.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: RSC or IMC.
 2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 3. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: RSC. Includes raceways in the following locations:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Parking Garages.
 - e. Transformer vaults.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: RSC.
 7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.

8. Surface Mounted Raceway
 - a. Combination Power and Communications surface non-metallic raceway – Where shown on drawings to serve receptacles and low-voltage devices.
 - b. Surface Metal Raceway – Where subject to physical damage to serve receptacles or devices on existing block or concrete walls that cannot be fished. Includes raceways in the following locations:
 - 1) Corridors
 - 2) Storage Rooms
 - 3) Mechanical Rooms/Equipment Rooms
 - 4) Kitchens
 - c. In existing accessible wall locations – branch circuits shall be concealed to serve devices.
 - d. In new construction, all branch circuiting to be concealed in construction.
- C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Rigid and Intermediate Steel Conduit: Use threaded galvanized rigid steel conduit fittings, unless otherwise indicated.
 2. EMT: Compression watertight or drive-on watertight.
 3. FMC: Set screw or thread-in type as approved by the enforcing Code.
- E. Use fittings made of the same material as the raceway except:
 1. Malleable iron and steel are interchangeable.
 2. Die cast fittings may be used for flexible steel conduit, and for factory manufactured offsets.
 3. Use plastic insulated bushings for conduit sizes larger than 1 inch.
 4. Use steel insulated throat connectors for electrical metallic tubing where entering panel boards, switchboards, etc.
- F. Use steel fittings that are galvanized, cadmium-plated, or have other approved similar protective coating.
- G. Use double locknuts for terminating rigid conduit at sheet metal enclosures and equip conduit ends with bushings.
- H. Provide expansion fittings on every raceway larger than 1-1/2 inches, and use a 2 foot piece of seal tight on all conduit 1-1/2 inches and smaller where it crosses any building expansion joints. Verify exact location of building expansion joints shown on architectural and/or electrical drawings prior to installation of raceway.

3.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which two 90-degree bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- I. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 24 inches (600 mm) of slack at each end of pull wire.
- J. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- K. Surface mounted raceways to be secured to surface as specified in Division 26 Section "Hangers and Supports for Electrical Systems" and not rely on adhesive tape backing for support.
- L. Expansion-Joint Fittings (Metallic conduit): Provide expansion fittings on every raceway larger than 1-1/2 inches, and use a 24 inch piece of LFMC on all conduit 1-1/2 inches and smaller where it crosses any building expansion joints. Verify exact location of building expansion joints shown on architectural and/or electrical drawings prior to installation of raceway.
- M. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC in damp or wet locations not subject to severe physical damage.

- N. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- O. Set metal floor boxes level and flush with finished floor surface.
- P. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Warning labels and signs.
 - 4. Instruction signs.
 - 5. Equipment identification labels.
 - 6. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
 - 1. Power Circuits: Black letters on an orange field.
 - 2. Fire Alarm Circuits: Red letters on natural field.
 - 3. Legend: Indicate system or service and voltage, if applicable.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.3 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

2.4 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
 - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a black background. Minimum letter height shall be 3/8 inch (10 mm).

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength: 50 lb (22.6 kg), minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black, except where used for color-coding.

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.

B. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

C. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

D. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch (10-mm) high letters for emergency instructions at equipment used for power transfer and/or load shedding.

E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a five lines of text:

- 1) First Line: 1/2-inch (13-mm) letters on the first line stating equipment name.
- 2) Second line (if applicable): 3/8-inch (10-mm) letters stating the existing equipment name in Parentheses ().
- 3) Third line: 3/8-inch (10-mm) letters stating voltage/phase.
- 4) Fourth line: 3/8-inch (10-mm) letters stating the breaker number, panel name and room number/name (Owner's room number) from which the equipment is fed.

- 5) Fifth line: 3/8-inch (10-mm) letters stating function and/or equipment which it controls.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- 2. Receptacle Labeling: Label shall be using Dymo Posiprinter, black lettering on clear tape stating panel and breaker number from which it is fed.
- 3. Equipment to be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Emergency system boxes and enclosures.
 - f. Disconnect switches.
 - g. Enclosed circuit breakers.
 - h. Motor starters.
 - i. Push-button stations.
 - j. Remote-controlled switches, dimmer modules, and control devices.
 - k. Fire-alarm control panel and annunciators.
 - l. Monitoring and control equipment.
 - m. Receptacles

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Colors for 208/120-V Circuits:
 - a. Phase A: Black.

- b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
- 2. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Grey
- 3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

END OF SECTION 260553

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes computer-based, fault-current, overcurrent protective device coordination studies, and ARC flash hazard study. Protective devices shall be set based on results of the protective device coordination study.
- B. The study shall provide information required for all equipment associated with the project. Study need only extend as far up stream as necessary to establish the required system coordination and arc flash data for the project.

1.3 SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
- C. Qualification Data: For coordination-study specialist.
- D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form. (The following submittals shall be made prior to granting final approval of the distribution equipment shop drawings and prior to release of equipment for manufacture.)
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.
 - 4. ARC Flash Hazard Study
 - 5. CD ROM of report.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

- B. Coordination-Study Specialist Qualifications: A licensed engineer experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide SKM Systems Analysis, Inc. or a comparable product by one of the following:
 - 1. Operation Technology, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Complete study prior to final release of equipment for manufacture.
- B. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and preliminarily approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance, coordinate with Utility.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, instantaneous and GFCI adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchgear, switchboards and motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Switchgear and switchboard bus.
 2. Medium-voltage controller.
 3. Motor-control center.
 4. Distribution panelboard.
 5. Automatic transfer switch.

6. Branch circuit panelboard.
 - B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
 - C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
 - D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 4. Low-Voltage Fuses: IEEE C37.46.
 - E. Study Report:
 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
 - F. Equipment Evaluation Report:
 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- 3.4 COORDINATION STUDY
- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.

- B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH WARNING LABELS

- A. Provide a 3.5 inch by 5 inch thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD," and shall include the following information:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance
 - 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field marking.
- D. ARC flashing labels shall be provided in the following manner, and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 480 and applicable 208 volt panelboards and disconnects, one ARC flash label shall be provided.
 - 2. For each low voltage switchboard, one ARC flash label shall be provided.

3.6 ARC FLASH WARNING LABELS

- A. The equipment vendor shall train personnel of the potential ARC flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals.

END OF SECTION 260573

SECTION 260580 - ELECTRICAL POWERED EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specifications sections, apply to this section.

1.2 DESCRIPTION

- A. This section of the specifications describes the principal electrical work related to the installation, connection, and control of electrical powered equipment furnished under other divisions. Should examination of related work indicate discrepancies or omissions, request clarification prior to performing or omitting any electrical work.
- B. Examine Contract Drawings and other divisions of these specifications to ascertain the extent of powered equipment covered by the drawings and specifications and the method by which each item of equipment shall be furnished, delivered to the site, installed, and the amount of electrical work which shall be included with the powered equipment. Verify the voltage and frequency requirements of electrical equipment as it is delivered to the site. If voltage and frequency are not compatible with the building electrical system, immediately inform the Architect in writing. Particular attention is called to the following items:
 - 1. Electric motors
 - 2. Mechanical equipment
 - 3. Motor operated doors
 - 4. Hospital equipment

1.3 DEFINITIONS

- A. Power Wiring: Contactors, conduit, enclosures, connections, labor and miscellaneous items to supply power to powered equipment and their associated controls for proper operation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Refer to other related sections of Division 26 for applicable materials. Particular attention is called to the following sections:
 - 1. Section 262816, Enclosed Switches and Circuit Breakers

PART 3 - PART 3 - EXECUTION

3.1 ELECTRIC MOTORS

- A. Motor Installation and Connections: Utility motors such as fans, pumps, etc., are provided under applicable sections of the specifications. Provide power wiring, including a check for correct rotation. Connect each motor to a separate branch circuit, except where shown otherwise. Terminate conduit to motors in final connection with liquid-tight flexible conduit.

- B. Control Devices and Wiring: Control devices (such as pressure switches, floats, electrodes, P.E. switches, E.P. switches, relays, thermostats, etc.), prewired in packaged type equipment and/or control panels shall be provided by the appropriate contractor.
- C. Verify motor rotation for equipment before it is turned over to other contractors or the Owner.

3.2 ELECTRICAL WORK FOR MECHANICAL EQUIPMENT

- A. Motors and Motor Controls: Pre-wired packaged type equipment, control devices, control panels and alarm panels for Mechanical Work, shall be furnished and installed under other divisions of the specifications and wired under this section of the specifications, except as otherwise noted. Control devices which have piping connections shall be installed under other divisions of the specifications. Where wall space is not available, provide suitable angle iron framework supports for mounting of starters and controls. Power wiring shall be provided to motors, starters, motor control centers, Engineer's Console, and each refrigeration machine, electric boilers, and auxiliaries. Perform required adjustments, wiring modifications, in conjunction with any testing and operational system start-up procedures. In general, starters, disconnects, switches and fuses shall be furnished under Divisions 21, 22, and 23 and wired under this division.
- B. Responsibility: Electrical work specified in Divisions 21, 22, and 23 as "by the Electrical Contractor" is an obligation of this contractor, the same as if specified herein.
 - 1. Electric Heaters: electric heaters are furnished under other Sections. Provide power wiring at heaters. Thermostats for heaters furnished under other sections.
 - 2. Control Wiring for HVAC Systems: control wiring of HVAC equipment shall be under Division 23 unless noted otherwise on electrical drawings.
 - 3. Smoke Dampers: smoke dampers are furnished under other Sections. Provide power and fire alarm wiring of smoke dampers for smoke damper operation in accordance with Division 23.

3.3 MOTOR OPERATED DOORS

- A. Provide power wiring as required. Motors, controls, limit switches, control pushbutton switches, and magnetic reversing contactors provided under other divisions but installed under this section.

3.4 ELECTRIC WORK HOSPITAL EQUIPMENT

- A. Provide power wiring and terminations to diagnostic equipment, examination lighting, overhead booms, radiology equipment, etc. Equipment is provided by the owner under a separate contract.
- B. Coordinate installation and requirements with the equipment manufacturer.

END OF SECTION 260580

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Transient voltage suppression panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.

- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate ratings, size, profiles, and dimensional requirements of panelboards and are based on the specific, fully rated, system indicated. Refer to Division 01.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2000 m).

- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Construction Manager/Owner no fewer than 10 days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Construction Manager's/Owner's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D.
 - 2. Transient Voltage Suppression Panelboards:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. Siemens Energy & Automation, Inc.
 - c. Square D.

2.2 MANUFACTURED UNITS

- A. Enclosures: Flush- and surface mounted cabinets. NEMA PB 1, Type 1.
 - 1. Front: Bolted to panel tub. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 2. Hinged Front Cover: Door in door; Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 - 4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- B. Phase and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus Configured Terminators: Mechanical type.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed piano hinges; secured with metal flush latch with tumbler lock; keyed alike.

2.5 TRANSIENT VOLTAGE SUPPRESSION PANELBOARDS

- A. Doors: Secured with vault-type metal latch with tumbler lock; keyed alike. Provide keyed system per owner's requirements.
- B. Main Overcurrent Devices: Thermal-magnetic circuit breaker.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.
- D. Bus: Copper phase and neutral buses.
- E. Transient Voltage Suppression Device: IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.

1. Minimum Single-Impulse Current Ratings:

- a. Line to Neutral: 100,000 A.
- b. Line to Ground: 100,000 A.
- c. Neutral to Ground: 50,000 A.

2. Protection modes shall be as follows:

- a. Line to neutral.
- b. Line to ground.
- c. Neutral to ground.

3. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
4. Maximum Category C Combination Wave Clamping Voltage: 600 V, line to neutral and line to ground on 120/208 V.
5. Maximum UL 1449 Clamping Levels: 400 V, line to neutral and line to ground on 120/208 V and 800 V.
6. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. GFCI Circuit Breakers: Single- and two-pole configurations with 30 mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

2.7 FUSED SWITCH: NEMA KS 1, TYPE HD; CLIPS TO ACCOMMODATE SPECIFIED FUSES; LOCKABLE HANDLE.

- A. Fuses are specified in Division 26 Section "Fuses."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Install overcurrent protective devices.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Arrange conductors in gutters into groups and bundle and wrap with wire ties upon completion of load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with self-adhesive laminated-plastic nameplate mounted.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Load Balancing: After Substantial Completion, but not more than 30 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Dead-Front GFCI Devices
 - 3. Hospital-grade receptacles.
 - 4. Toggle switches and wall-box dimmers.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 2. Leviton Mfg. Company Inc. (Leviton).
 - 3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL5361 (single), HBL5362 (duplex).
 - b. Leviton; 5891S (single), 5352S (duplex).
 - c. Pass & Seymour; 5381 (single), 5352 (duplex).
- B. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL8310 (single), HBL8300H (duplex).
 - b. Leviton; 8310 (single), 8300 (duplex).
 - c. Pass & Seymour; 9301-HG (single), 9300-HG (duplex).
- C. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; GFRST83.
 - b. Leviton; 6898-HG.
 - c. Pass & Seymour; 2091-SHG.

2.3 TOGGLE SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
 - b. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - c. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.4 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material: Satin-finished stainless steel 0.04 inch thick.

2.5 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: Black or As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Utilized as Dedicated Computer Circuits: Gray.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
 - 5. Install switches on lock set side of doorways.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 LOCATION OF DEVICES

- A. The approximate schematic location of devices is given on the drawings. The exact location shall be determined at the building as the work progresses. Refer to Architectural plans for any special details, elevations, and reflective ceiling plan. Verify door swings at job site. In no case shall switches be located behind door swings. Any switch so located shall be changed. Field verify equipment locations and adjust device and outlet locations to avoid inaccessibility. Relocate inaccessible outlets.
- B. Dead-Front GFCI Devices to be installed in readily accessible location near downstream devices it protects.
- C. Unless otherwise indicated, or otherwise decided at the site, outlet boxes in walls shall be located with centerline at elevation above the finished floor as shown on table.
- D. The Architect and the Owner reserve the right to change the location of any outlet, before it has been installed.

3.3 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
 1. Receptacles: Identify panelboard and circuit number from which served. Dymo Posi Printer machine printing with black filled lettering on clear tape on face of plate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
 2. Test Instruments: Use instruments that comply with UL 1436.
 3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 5 percent or higher is not acceptable.
 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

- C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions Division 01 and Division 26 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 600 V and less for use in switches.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 33 percent of each fuse type and size, but no fewer than 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc..
- B. All fuses shall be indicator type employing either an indicator window or mechanical indicator striker pin.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Motor Branch Circuits: Class RK1 time delay.

- B. Other Branch Circuits: Class RK1, time delay

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. HD: Heavy duty.
- C. RMS: Root mean square.
- D. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - 4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

- B. Shop Drawings: Diagram power, signal, and control wiring. Retain paragraph and subparagraphs below if required by seismic criteria applicable to Project.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. Siemens Energy & Automation, Inc.
 - 3. Square D/Group Schneider.
- B. Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Control Division.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D/Group Schneider.

- B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
- C. Molded-Case Circuit-Breaker Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

3.2 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 262816

SECTION 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for surge protection for low voltage electrical power circuits as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. Section Includes: The work specified in this Section includes, but shall not be limited to, the following:
 - 1. Requirements for both field-mounted SPDs (externally mounted), and integrated SPDs (installed from the factory) for low voltage power distribution and control equipment.

1.2 REFERENCES

- A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. ANSI/IEEE C62.41.1, "Guide on the Surges Environment in Low Voltage (1000 V and Less) AC Power Circuits."
 - 2. ANSI/IEEE C62.41.2, "Recommended Practice on Characterization of Surges in Low Voltage (1000 V and Less) AC Power Circuits."
 - 3. ANSI/IEEE C62.45, "Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits."
- C. International Organization for Standardization (ISO):
 - 1. ISO 9001, "Quality Management Systems - Requirements."
- D. National Fire Protection Association (NFPA):
 - 1. NFPA 70, "National Electrical Code," hereinafter referred to as NEC.
- E. Underwriters Laboratories, Inc. (UL):
 - 1. UL 67, "Standard for Panelboards."
 - 2. UL 96A, "Standard for Installation Requirements for Lightning Protection Systems."
 - 3. UL 845, "Motor Control Centers."
 - 4. UL 857, "Busways."
 - 5. UL 891, "Switchboards."
 - 6. UL 1283, "Standard for Safety for Electromagnetic Interference Filters."
 - 7. UL 1449, "Standard for Surge Protective Devices."
 - 8. UL 1558, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear."

1.3 DEFINITIONS

- A. I(n): Nominal discharge current rating.
- B. MCOV: Maximum continuous operating voltage.
- C. Protection Modes: The pair of electrical connections where the VPR applies.
- D. MOV: Metal oxide varistor; an electronic component with a significant non-ohmic current voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

1.4 SYSTEM DESCRIPTION

- A. General SPD Requirements:
 - 1. SPD with accessories shall be listed and labeled as defined in NEC, by UL, and marked for intended location and application.
 - 2. Comply with UL 1449.
 - 3. Comply with UL 1283 (applies to Type 2 SPDs).
 - 4. Design in accordance with ANSI/IEEE C62.41.1, ANSI/IEEE C62.41.2, and ANSI/IEEE C62.45.
 - 5. SPDs manufacturer shall be ISO 9001 certified.
 - 6. MCOV of the SPD shall not be less than 115 percent for 480Y/277V and 125 percent for 208Y/120V nominal RMS system voltages.
 - 7. SPDs installed internal to the distribution equipment shall be of the same manufacturer as the equipment. The equipment shall be fully tested and certified to the following UL standards:
 - a. Panelboards: UL 67.
 - b. Motor Control Centers: UL 845.
 - c. Busway: UL 857.
 - d. Switchboards: UL 891.
 - e. Switchgear: UL 1558.

1.5 SUBMITTALS

- A. General: See [Section 01 33 00 - Submittal Procedures] [Section 01300 - Submittals].
- B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.
 - 1. For each type of product indicated include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Provide verification the SPD is listed or recognized through UL to the latest safety standard, UL 1449.
 - C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data.
 - D. Operation and Maintenance Data: Submit operation and maintenance data for surge protection for low voltage electrical power circuits to include in operation and maintenance manuals.
 - E. Warranty Data: Submit sample of special warranties.
- 1.6 QUALITY ASSURANCE
- A. Qualifications:
 1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of surge protection for low voltage electrical power circuits of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years.
 2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing surge protection for low voltage electrical power circuits similar in type and scope to that required for this Project and shall be approved by the manufacturer.
 - B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
 - C. Single Source Responsibility: Obtain surge protection for low voltage electrical power circuits and required accessories from a single source with resources to produce products of consistent quality in appearance and physical properties without delaying the work. Any materials which are not produced by the manufacturer shall be acceptable to and approved by the manufacturer.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.
 - B. Store materials in their original, undamaged packages and containers, inside a well ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
- 1.8 WARRANTY
- A. General: See [Section 01 77 00 - Closeout Procedures] [Section 01770 - Closeout Procedures].
 - B. Special Warranty: Submit a written warranty executed by the manufacturer, the Installer, and the Contractor, agreeing to repair or replace surge protection for low voltage electrical power circuits that fail in materials or workmanship within the specified warranty period.
 1. Warranty Period: Warranty period shall be 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Product specified is "Surgeologic Surge Protection" as manufactured by Square D by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.
- B. Alternate manufacturers

2.2 SERVICE ENTRANCE SUPPRESSORS

- A. SPDs: Comply with UL 1449.
 - 1. SPDs installed on the line side of the service entrance OCPD shall be Type 1 SPDs. SPDs installed on the load side of the service entrance OCPD shall be either Type 1 or Type 2 SPDs.
 - 2. Type 2 SPDs shall also comply with UL 1283.
- B. Features and Accessories: SPDs shall provide the following features and accessories:
 - 1. Internal fusing design capable of disconnecting the SPD before any damaging external effects to the suppressor or surroundings occur.
 - 2. Indicator light(s) display for power and protection status with push-to-test capabilities.
 - 3. Audible alarm with silencing switch.
 - 4. Form C contacts; one normally open and one normally closed for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - 5. Surge counter with reset switch.
 - 6. Optional integral disconnect switch for externally mounted SPDs. SPDs integrated into factory supplied equipment shall have an input disconnect switch or circuit breaker unless indicated on the equipment drawings/data sheets.
- C. Surge Current Rating: The surge current rating of the SPD shall be dependent of its category/location, as follows:

Category/Location	Application	Per Phase	Per Mode
C	Service Entrance	240 kA	120 kA
B	Distribution	160 kA	80 kA

- D. Protection Modes:
 - 1. UL 1449 VPR for grounded WYE configured circuits shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	800 volts	1200 volts	1500 volts
L-L	1200 volts	2000 volts	2500 volts

2. UL 1449 VPR for Delta configured circuits shall not exceed the following:

Modes	240D	480D	600D
L-G; N-G	1200 volts	2000 volts	2500 volts

- E. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the available short circuit current at the point on the system where installed.
- F. Nominal Discharge Current Rating: 20 kA I(n).
1. Surge protective devices located at service entrance locations shall carry a minimum nominal discharge current rating of 20 kA to meet the requirements of UL 96A.

2.3 DISTRIBUTION/ BRANCH PANEL SUPPRESSORS

- A. SPDs: Comply with UL 1449.
1. Type 1 or Type 2 SPDs.
2. Type 2 SPDs shall also comply with UL 1283.
- B. Features and Accessories: SPDs shall provide the following features and accessories:
1. Internal fusing design capable of disconnecting the SPD before any damaging external effects to the suppressor or surroundings occur.
2. Indicator light(s) display for power and protection status.
3. Audible alarm with silencing switch.
4. Form C contacts; one normally open and one normally closed for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
5. Surge counter with reset switch.
6. Optional integral disconnect switch for externally mounted SPDs. SPDs integrated into factory supplied equipment shall have an input disconnect switch or circuit breaker unless indicated on the equipment drawings/data sheets.
- C. Surge Current Rating: The surge current rating of the SPD shall be dependent of its category/location, as follows:

Category/Location	Application	Per Phase	Per Mode
B	Distribution	160 kA	80 kA
B	Branch	120 kA	60 kA

- D. Protection Modes:
1. UL 1449 VPR for grounded WYE configured circuits shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	800 volts	1200 volts	1500 volts
L-L	1200 volts	2000 volts	2500 volts

2. UL 1449 VPR for Delta configured circuits shall not exceed the following:

Modes	240D	480D	600D
L-G; N-G	1200 volts	2000 volts	2500 volts

- E. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the available short circuit current at the point on the system where installed.
- F. Nominal Discharge Current Rating: 10 kA I(n).

2.4 ENCLOSURES

- A. Enclosure shall meet or exceed the ratings for the environment to be installed as indicated on drawings.
- Indoor Enclosures for Externally Mounted SPDs: NEMA 250, Type 3R.
 - Outdoor Enclosures for Externally Mounted SPDs: NEMA 250, Type 3R, 4X.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

- A. Install surge protection for low voltage electrical power circuits in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- B. Install SPD devices at the service entrance in accordance with NEC. SPDs installed on the line side of the service entrance OCPD shall be Type 1 SPDs. SPDs installed on the load side of the OCPD shall be either Type 1 or Type 2 SPDs.
- C. Follow manufacturer's recommended installation practices.
- Provide a minimum 30 ampere circuit breaker as a dedicated disconnecting means for the SPD unless otherwise indicated.
 - Install SPDs with properly rated conductors between suppressor and points of attachment as short and straight as possible; adjust circuit breaker positions to achieve shortest and straightest leads.
 - Do not splice and extend SPD leads unless specifically permitted by manufacturer.
 - Twist input conductors together to reduce the input inductance.

3.3 FIELD QUALITY CONTROL

- A. See [Section 01 45 23 - Inspecting and Testing Services] [Section 01410 - Inspecting and Testing Services].
- B. Perform the following tests and inspections.
 - 1. Compare equipment nameplate data for compliance with the Drawings and the Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- C. A SPD will be considered defective if it does not pass inspections.
- D. Prepare inspection reports.

3.4 DEMONSTRATION

- A. Start-Up Service:
 - 1. Complete start-up checks according to manufacturer's written instructions.
 - 2. Do not perform insulation resistance tests of the distribution wiring equipment with SPDs installed. Disconnect all wires, including, but not limited to, neutral of the SPD before conducting insulation resistance tests, and reconnect them immediately after the testing is over.
 - 3. Energize SPDs after power system has been energized, stabilized, and tested.

3.5 PROTECTION

- A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the surge protection for low voltage electrical power circuits shall be without damage at time of Substantial Completion.

END OF SECTION 264313

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
 - 5. Retrofit kits for fluorescent lighting fixtures.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. RCR: Room cavity ratio.
- H. Fixture: A complete lighting unit, exit sign, or emergency lighting unit. Fixtures include lamps and parts required to distribute the light, position and protect lamps, and connect lamps to the power supply.
- I. Modified Standard: A manufacturer's standard product that has been modified in any manner to conform to the specified fixture and these specifications.

- J. Custom Fixture: Any fixture that is not a standard product of the specified manufacturer that is constructed to conform to the design and specifications shown.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Driver.
 - 4. Energy-efficiency data.
 - 5. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, identical to those indicated for the lighting fixture as applied in this Project. Photometrics shall be either of the following:
 - a. Photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
 - b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of modified standard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 - 1. Wiring Diagrams: Power and control wiring, where applicable.
- C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Lighting fixtures.
 - 2. Suspended ceiling components.
 - 3. Structural members to which suspension systems for lighting fixtures will be attached.
 - 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.

- c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.
 - f. Access panels.
 - 5. Perimeter moldings.
 - D. Qualification Data: For agencies providing photometric data for lighting fixtures.
 - E. Field quality-control test reports.
 - F. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 - G. Warranties: Special warranties specified in this Section.
- 1.5 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - B. Comply with NFPA 70.
- 1.6 COORDINATION
- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, structural steel members, and partition assemblies.
 - B. For fixtures installed in hard ceilings, provide plaster rings if required.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
 - 2. warranty shall apply for first year, and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Lighting fixtures shall be provided from the manufacturers listed in the Lighting Fixture Schedule as part of the contract drawings.
- B. Where more than one manufacturer is listed the first manufacturer is the basis of design. Alternate manufacturers are listed as potential sources of product equal to the basis of design. Listing of alternate manufacturers does not guarantee that an equal product is available as a standard product offering. A custom or modified version of a standard product, provided by one of the alternate manufacturers and a level of quality established by the standard series shown, will be reviewed for approval. Product will be accepted if technical specifications as well as aesthetic qualities meet or exceed those of the specified manufacturer. The architect reserves the right to reject or modify the proposed fixture from the alternate manufacturer as needed to match the specifications of the fixture chosen as the basis of design.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. All sheet metal work shall be free from tool marks, dents, and burrs. Unless otherwise indicated all sheet metal shall be a minimum of #20 gauge cold rolled sheet steel. Bent angles shall be formed as sharp as compatible with the gauge of the steel. All intersections and joints shall be formed true and of adequate strength and structural integrity to prevent any distortion after assembly. Edges of sheet metal components shall be finished such that no sharp edges are exposed. Splices and or filler pieces used to cover poor or defective workmanship will not be accepted. All sheet metal components shall be free of light leaks.
- B. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked paint process to prevent corrosion and discoloration of adjacent materials.
- C. Hardware for steel and aluminum fixtures shall be cadmium or equivalent plated. Hardware for stainless steel fixtures shall be stainless steel. Hardware for bronze fixtures shall be stainless steel or bronze.
- D. Acrylic lenses and diffusers shall be formed of colorless 100% virgin acrylic plastic. Acrylic plastic lenses and diffusers shall be properly cast, molded, or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for a period of 15 years. Acrylic lenses shall be a minimum of 0.125" pattern #12 acrylic.
- E. Vandal resistant lenses shall be formed from ultraviolet (UV) stabilized polycarbonate.
- F. Glass used for lenses, refractors, and diffusers in incandescent light fixtures shall be tempered for high impact and heat resistance. Glass shall be crystal clear in quality and not less than 88% transmittance.
- G. Reflectors shall be formed sheet aluminum in a specular, semi-specular, or diffused finish as indicated in fixture schedule. Alzak reflectors shall be guaranteed against discoloration for a period of ten years.
- H. All doors, frames, and other internal access shall be smooth operating and free from light leakage on all sides of the fixture under operating conditions.
 - 1. All general purpose troffers shall have spring-loaded cam latch doors. Provide gasketing or mechanical light leak protection on all sides of the fixture.

2. All recessed downlights and wallwashers shall have metal trim rings.

- I. Fixtures installed in gypsum board ceilings or plaster ceilings shall be provided with plaster frames. Plaster frames shall be braced temporarily to prevent distortion during installation.
- J. All fixtures shall be furnished with all internal wiring completed by the manufacturer.

2.3 LED LIGHTING

- A. Description: Fixtures to be designed and tested with long life LED's coupled with high efficiency drivers rated to deliver L80 performance for 50,000 hours.
- B. Listings:
 - 1. Fixtures to have DLC certified test to LM80 standings.
 - 2. Photometrics to be tested in accordance to IESNA LM-79
 - 3. Exterior fixtures to be listed for exterior use.
- C. Drivers: Drivers to deliver full-range dimming from 0-10V control.
- D. Warranty: Fixtures to be provided with 5 year warranty on all parts and 5 year limited warranty on fixture replacement.

2.4 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction and as specified in fixture schedule.
- B. Internally Lighted Signs:
 - 1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 - 2. Edge-Lit Exit Signs shall be provided with a recessed housing. Panels shall be injection-molded clear acrylic with a mirrored face.

2.5 EMERGENCY LIGHTING UNITS

- A. Description: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
7. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.7 REQUIREMENTS FOR INDIVIDUAL LIGHTING FIXTURES

- A. See lighting fixture schedule included as part of contract drawings for requirements for individual fixtures.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to architectural reflected ceiling plans, elevations and section drawings for exact locations of fixtures. Do not scale the electrical drawings for exact locations of the lighting fixtures.
- B. Furnish lighting fixtures complete with all appurtenances required for the proper, safe, and distortion-free installation in the various surfaces in which they appear. Determine surface types from the architectural drawings.
- C. Fixtures shall be installed in accordance with Article 410 of the National Electrical Code.
- D. All fixtures in a given area shall have all visible components, lamps, baffles, lenses, etc., oriented in the same direction.
- E. Surface mounted fixtures shall be installed level, plumb, and square with respect to ceilings and walls. Fixtures shall be secured according to the manufacturer's written instructions and approved submittal materials.
- F. Fixtures noted as installed in a grid ceiling shall be installed in the center of a ceiling tile, unless noted otherwise.
- G. Fixtures recessed in grid ceilings shall be supported independent of the ceiling system. Fixtures shall be supported as follows:
 - 1. For nominal fixture sizes, 2x4, 2x2, and 1x4, provide a minimum of four support rods or wires, minimum 12 gauge wire, for each fixture. Wires shall be located not more than 6" from fixture corners. Wires shall be installed such that the fixture is supported from the building structure and not from the grid ceiling.
 - 2. Provide support clips as required to fasten fixtures to the ceiling grid members in addition to supporting the fixture from the building structure.

3. Fixtures of sizes less than the structural grid shall be installed with a minimum of two $\frac{3}{4}$ " metal channels spanning and secured to the structural grid. Metal channels shall also be supported from the building structure with a minimum of #12 gauge wire, with a minimum of one support per fixture.
- H. Fixtures recessed in hard ceilings shall be installed with aperture and/or trim rings flush to the underside of the ceiling system. Cut-outs for fixtures shall be coordinated with fixture aperture size such that the trim ring will cover the cut-out in its entirety.
- I. Fixtures recessed in ceilings with a fire rating of one hour or more shall be enclosed in a box which has a fire resistance rating equal to that of the ceiling.
- J. Fixtures installed surface mounted to a grid ceiling shall be supported from structural members independent of the grid ceiling.
- K. Pendant mounted strip fixtures, industrial reflectors, or lensed wrap-around fixtures shall be installed with a minimum of two supports per 4' section or three supports per 8' section.
- L. All fixtures shall be installed with the proper lamps as described in the Lighting Fixture Schedule. All lamps shall be operational after installation is complete.
- M. Emergency Lighting Units shall be installed unswitched on the circuit indicated on the drawings.

3.2 ELECTRICAL CONNECTIONS

- A. All fixtures shall be grounded in accordance with Article 250 of the National Electrical Code.
- B. Fixture connections shall be made via flexible conduit from the junction box to the fixture, length not to exceed 6'. Direct wiring between fixtures shall not be permitted.
- C. Use Health Care Facilities Cable (Type HCF) in lengths not to exceed 6' from the junction box to the fixture.
- D. All low voltage wiring shall be as recommended by the fixture manufacturer. Low voltage wiring shall be a minimum of #12 AWG copper conductors. Voltage drop shall not exceed 5% of nominal voltage, increase wire size as required.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage including but not limited to, scratches, dents, defective parts, cracked lenses, etc. Replace damaged fixtures and components as required.
- B. Test and inspect all fixtures connected to the emergency generator system. Provide advance notice of the test to the architect. Testing procedure shall be as follows:
 - 1. Verify normal operation of each fixture.
 - 2. Interrupt normal electrical supply to demonstrate proper transfer to emergency power.
 - 3. Check intensity and uniformity of illumination with a photometer calibrated to NIST standards.
 - 4. Verify all exit signs are properly illuminated to comply with NFPA 101 requirements.
 - 5. Retransfer power source to normal power.
- C. Test and inspect all emergency battery units. Provide advance notice of the test to the architect. Testing procedure shall be as follows:
 - 1. Verify normal operation of each fixture.
 - 2. Interrupt normal electrical supply to demonstrate proper transfer to battery power.
 - 3. Check intensity and uniformity of illumination with a photometer calibrated to NIST standards for initial illumination and for illumination after 90 minutes of battery operation.
 - 4. Verify aiming of lamps, to properly illuminate the path of exit.
 - 5. Verify all exit signs are properly illuminated to comply with NFPA 101 requirements for a period of 90 minutes.
 - 6. Retransfer power source to normal power.

3.4 CLEANING AND PROTECTION

- A. Clean all fixtures internally and externally after installation. Use methods and materials as recommended by the manufacturer.
- B. Retain protective plastic on parabolic louvers until interior finishes are complete.

- C. Aluminum reflectors for linear fluorescent fixtures and downlights shall be installed such that oils and fingerprints do not etch the reflecting surface. Reflectors with damage caused by improper installation methods shall be replaced.

END OF SECTION 265100

SECTION 27 00 00 - GENERAL COMMUNICATIONS PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Scope of Work.
 - 2. Intent of Drawings.
 - 3. Pre-Bid Site Visit.
 - 4. Definitions.
 - 5. General Standards of Materials.
 - 6. Products and Substitutions.
 - 7. Applicable Codes.
 - 8. Guarantees and Certificates.
 - 9. Quiet Operation and Vibration Control.
 - 10. Temporary Shutdown of Existing Systems.
 - 11. Coordination.
 - 12. Shop Drawings, Product Data, and Samples.
 - 13. Owner Instruction.

1.3 SCOPE OF WORK

- A. The scope of the work included under Division 27 of the specifications shall include complete systems as shown in the Contract Documents and specified herein. Any work reasonably inferable or required to result in a complete installation or the intended operation and performance of the systems, shall be included in the Base Bid except where there is specific reference to exclusion and incorporation in other quotations.
- B. A brief written Scope of Work appears in Division 01.
- C. Contractor shall be solely responsible for all parts, labor, testing, documentation and all other processes and physical apparatus necessary to turn over the completed cabling system and associated infrastructure fully warranted and operational for acceptance by the Owner.
- D. Provide the telecommunication system conduit (with pull string), boxes, cable tray, and raceways in complete accordance with the specifications and the information found on the drawings.
- E. This section specifies work to be provided by the contractor, to include furnishing and installation of cabling, jacks, terminal blocks and terminations. Installation of communications cabling and performing any terminations in the MDF or IDF closets and at all room voice and data jacks will be the responsibility of this cabling contractor.

- F. This specification includes structured cabling design considerations, product specifications and installation guidelines for low-voltage network systems and associated infrastructure including, but not limited to:

1. Horizontal Copper
2. Intrabuilding Backbone Cabling
3. Interbuilding Backbone Cabling
4. Telecommunications Pathways
5. Communications Racks and Cable Managers
6. Communications Grounding Systems
7. Cabling Labeling and Administration
8. Audiovisual Systems Infrastructure
9. Security Systems Infrastructure

1.4 QUALITY ASSURANCE

- A. Contractor Resume: a resume of qualifications shall be submitted with the Contractor's proposal indicating the following:
1. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
 2. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic cable systems on this project.
 3. A technical resume of experience for the contractor's Project Manager and on-site installation supervisor who will be assigned to this project.
 4. A list of technical product training attended by the contractor's personnel that will install the system shall be submitted with the response.
 5. Any sub-Contractor, who will assist the primary contractor in performance of this work, shall have the same training and certification as the prime contractor.
- B. Prior to beginning any cable installation or terminations, the contractor will meet with the Owner, IT department, Electrical Contractor and the General Contractor to discuss all procedures and requirements and to review the condition of the conduit and raceway installations, plus layout of all new closets both (MDF's and IDF's).

1.5 INTENT OF DRAWINGS

- A. Provide complete and functional systems for the project. The systems shall conform to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform with accepted trade practices. The drawings and specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this Contractor's work.
- B. Do not scale the drawings. Because of the scale of the drawings, it is not possible to indicate offsets, fittings, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Install systems in such a manner that interferences between pipes,

conduit, ducts, equipment, architectural and structural features are avoided. Provide items required to meet the project conditions without additional cost to the owner.

- C. These documents may not explicitly disclose final details required for a complete systems installation; however, contractors shall possess the expertise to include the necessary appointments of complete operating systems.
- D. Contractors shall be experienced in this type of construction and realize the extent of the work required.

1.6 PRE-BID SITE VISIT

- A. Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions.

1.7 DEFINITIONS

- A. Specific terminology, as used herein, shall have the following meanings:
 - 1. "Furnish"...Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar subsequent requirements.
 - 2. "Install"...Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.
 - 3. "Provide"...Furnish and install, complete and ready for intended use.
 - 4. "Concealed, Interior"...Concealed from view and protected from physical contact by building occupants.
 - 5. "Concealed, Exterior" ...Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures.
 - 6. "Exposed, Interior"...Exposed to view indoors (not concealed).
 - 7. "Exposed, Exterior"...Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
 - 8. "Finished Space" ...Space other than mechanical rooms, electrical rooms, furred spaces, pipe chases, unheated spaces immediately below roof, space above ceilings, unexcavated spaces, crawl spaces, tunnels, and interstitial spaces.
 - 9. "Conditioned"...Spaces directly provided with heating and cooling.
 - 10. "Unconditioned"...Spaces without heating or cooling including ceiling plenums.
 - 11. "Indoors"...Located inside the exterior walls and roof of the building.
 - 12. "Outdoors"...Located outside the exterior walls and roof of the building.

1.8 GENERAL STANDARDS OF MATERIALS

- A. Equipment and materials, unless otherwise noted, shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five years.
- B. Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts and components.
- C. Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.
- D. With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.

1.9 PRODUCTS AND SUBSTITUTIONS

- A. Where a specific manufacturer's product is specified, the Contract Amount shall be based on that product only. Refer to Division 01 for requirements.
- B. Where several manufacturer's products are specified, the Contract Amount shall be based upon the specified products only. Refer to Division 01 for requirements.
- C. It is the intent of these specifications that service organizations follow the above substitution procedures.

1.10 APPLICABLE REGULATORY REFERENCES AND CODES

- A. Materials furnished and work installed shall comply with applicable codes listed in Division 01, with the requirements of the local utility companies, and with the requirements of governmental departments or authorities having jurisdiction.
- B. Contractor is responsible for knowledge and application of current versions of all applicable standards and codes. In cases where listed standards and codes have been updated, Contractor shall adhere to the most recent revisions, including all relevant changes or addenda at the time of installation.
- C. ANSI/TIA:
 - 1. ANSI/TIA-568.0-E (March 2020) Generic Telecommunications Cabling for Customer Premises
 - 2. ANSI/TIA-568.1-E (March 2020) Commercial Building Telecommunications Infrastructure Standard

3. ANSI/TIA-568.2-E (October 2024) Balanced Twisted Pair Communications and Components Standards
 4. ANSI/TIA-568.3-E (September 2022) Optical Fiber Cabling and Components Standard
 5. ANSI/TIA-568.4-E (July 2022) Broadband Coaxial Cabling and Components Standard
 6. ANSI/TIA-569-E (May 2019) Telecommunications Pathways and Spaces
 7. ANSI/TIA-606-D (October 2021) Administration Standard for Telecommunications Infrastructure
 8. ANSI/TIA-607-E (May 2024) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 9. ANSI/TIA-862-C (June 2022) Structured Cabling Infrastructure Standard for Intelligent Building Systems
 10. ANSI/TIA-942-C (May 2024), Telecommunications Infrastructure Standard for Data Centers
 11. TIA-1152-A (November 2016) Requirements for Field Test Instruments and Measurements for Balanced Twisted- Pair Cabling
 12. ANSI/TIA-1183-B (February 2023) Measurement Methods and Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 13. TIA-TSB-184-A (March 2017) Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
 14. TIA-TSB-162-B (February 2021) Telecommunications Cabling Guidelines for Wireless Access Points
- D. BICSI – Building Industry Consultative Services International
1. Telecommunications Distribution Methods Manual, 15th Edition
 2. Information Technology Systems Installation Methods Manual (ITSIMM) 8th Edition
 3. Telecommunications Project Management Reference Manual (TPMRM), 2nd edition
 4. ANSI/BICSI 005-2016, Electronic Safety and Security (ESS) System Design and Implementation Best Practices
 5. ANSI/BICSI 006-2020, Distributed Antenna Systems (DAS) Implementation Best Practices

6. ANSI/BICSI 007-2024, Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises
 7. ANSI/BICSI 008-2024, Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices
 8. ANSI/BICSI N1-19, Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure
 9. ANSI/BICSI N2-17, Practices for the Installation of Telecommunications and ICT Cabling Intended to Support Remote Power Applications
 10. ANSI/BICSI N3-20, Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure
- E. National Electric Codes – all applicable
- F. OSHA Standards and Regulations – all applicable
- G. Local Codes and Standards – all applicable
- H. Anywhere cabling standards conflict with one another or with electrical or safety codes, Contractor shall defer to the NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.
- I. Knowledge and execution of applicable standards and codes is the sole responsibility of the Contractor.
- J. Any violations of applicable standards or codes committed by the Contractor shall be remedied at the Contractor's expense.

1.11 GUARANTEES AND CERTIFICATES

- A. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract resulting from same, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated guarantee periods.
1. Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of the equipment for temporary conditioning, testing, etc., prior to occupancy will not be considered part of the warranty period.
- B. Telecom Cabling Plant
1. General
 - a. Contractor shall provide a 25 year System Warranty on all copper and fiber permanent cabling links.

- b. It is understood the System Warranty is a system performance warranty guaranteeing for 25 years from acceptance that the installed system shall support all data link protocols for which that Category of copper cabling system or fiber OM/OS designation of fiber optic system is engineered to support according to current and future IEEE and TIA standards.
- c. Upon acceptance of Warranty, the Manufacturer will mail a notification letter to the installer and a notification letter and warranty certificate to the Owner.

2. Contractor Warranty Obligations

- a. Installation firm (Contractor) must be a current Manufacturer Certified Installer or approved equivalent manufacturer in good standing and shall include a copy of the company installation certification with the bid.
- b. Contractor shall name a supervisor to serve on site as a liaison responsible to inspect and assure all terminations are compliant to factory methods taught in Technician Certification Training, or approved equal, and according to all Standards cited in the Regulatory References section of this document.
- c. Contractor liaison (project supervisor) shall have a current, up-to-date Manufacturer certificate in both copper and fiber. Copies of the copper and fiber certificates shall be submitted with the bid.
- d. All intra-building new fiber optic installations shall utilize an appropriate cable construction as specified herein.
- e. Contractor shall install all racking and support structures according to cited Standards in such fashion as to maintain both cited industry standards as well as manufacturer recommendations for uniform support, protection, and segregation of different cable types.
- f. Contractor is responsible for maintenance of maximum pulling tensions, minimum bend radius, distance limitations, and approved termination methods as well as adhering to industry accepted practices of good workmanship.
- g. Contractor is responsible for understanding and submitting to the Manufacturer all documents required at project end. These include, but are not limited to: completed warranty forms, passing test reports and drawings of floor plans showing locations of links tested. These requirements are the same for accepted equivalent manufacturers.
- h. Test results shall be delivered in the tester's native format (not Excel) and represent the full test report, summaries shall not be accepted. All test shall be uniform, testing Permanent Link. Contractor shall use Manufacturer (or approved equivalent manufacturer) approved testers, test leads and latest operating systems.
- i. The Contractor will correct any problems and malfunctions that are warranty-related issues without additional charge to the Owner for the entire warranty period.

- j. The warranty period shall commence following the final acceptance of the project by the Owner and written confirmation of Warranty from the Manufacturer. These requirements are the same for accepted equivalent manufacturers.

1.12 QUIET OPERATION AND VIBRATION CONTROL

- A. Equipment and associated items shall operate under conditions of load without sound or vibration deemed objectionable by the Architect. In the case of moving equipment, sound or vibration noticeable outside of the room in which it is installed, or noticeable within the room in which it is installed, shall be deemed objectionable. Sound or vibration deemed objectionable shall be corrected in an approved manner at no extra cost to the Owner. Vibration control shall be provided by means of approved vibration isolators and installed in accordance with the isolator manufacturer's recommendations.
- B. The sound pressure levels around mechanical and electrical equipment in equipment spaces shall not exceed 85 dBA at any point three (3) feet from the equipment, with all equipment in the room operating. The sound criteria applies to the complete range of each piece of equipment.

1.13 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

- A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing systems. Some temporary shutdown of existing systems may be required to complete the work.
- B. Submit to the Owner in writing for approval, proposed date schedule, time, and duration of necessary temporary shutdowns of existing systems. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner. The Owner reserves the right to cancel shutdowns at any time prior to the shutdowns. To insure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections. No additional charges shall be allowed for Owner-canceled shutdowns that must be rescheduled.
- C. Shutdowns must be performed by the Owner or under Owner supervision. Do not shut-down any system. The Owner reserves the right to require a walk-through of any shutdown prior to the shutdown. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors.

1.14 COORDINATION

- A. Coordinate and furnish in writing to the Architect information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.
- B. Coordination drawings shall be prepared as defined in Division 01. No installation of permanent systems shall proceed until the coordination drawings are reviewed by the

Architect. No extra charges shall be allowed for changes required to accommodate installation of systems provided under other divisions of this contract.

- C. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
- D. When work is installed without proper coordination, changes to this work deemed necessary by the Architect shall be made to correct the conditions without extra cost to the Owner.

1.15 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- A. Shop drawings, product data, and samples shall be submitted in accordance with the provisions of Division 01.
- B. The following shall be submitted by the Contractor for review:
 - 1. Scale shop drawings showing system components with sizing indicated, including but not limited to:
 - a. equipment locations.
 - b. raceways
 - c. insert and sleeve locations
 - d. hangers, anchors and guides
 - e. expansion joints
 - f. access doors
 - 2. Product data for system components and materials (including construction standards).
 - 3. Samples of finishes and trim exposed to view, such as fixture trim, escutcheon plates and similar items.

1.16 RECORD DRAWING DOCUMENTATION

- A. Documentation - submit at the end of the project, as-built drawings of the raceway and cabling installation showing routing, sizes, terminal locations, cable numbers, etc.

1.17 OWNER INSTRUCTION

- A. After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be 16 man hours. The instruction period shall be broken into segments at the discretion of the Owner.
1. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one (1) week prior to conducting same.
 2. Forward to the Architect the signatures of all those present for the instruction periods.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 27 00 00

SECTION 27 05 00 - COMMON WORK FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Communications equipment coordination and installation.
 - 2. Common communications installation requirements.
 - 3. Excavating and backfilling.
 - 4. Demolition.
 - 5. Waterproofing.
 - 6. Weatherproofing locations.
 - 7. Cutting and Patching.
 - 8. Painting.
 - 9. Equipment Foundations, Supports, Piers and Attachments.
 - 10. Equipment Guards and Rails.
 - 11. Cleaning, Protecting and Adjusting.
 - 12. Welding.
 - 13. Sleeves for raceways and cables.
 - 14. Sleeve seals.
 - 15. Grout.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. Wiring: Cable and/or wire installed in Raceway.

1.4 SUBMITTALS

- A. Product Data
 - 1. For sleeve seals
 - 2. Engineered through penetration firestop sleeves
 - 3. Engineered smoke and acoustical sleeves

1.5 WATERPROOFING

- A. Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect prior to performing the work. Furnish necessary sleeves, caulking and flashing required to make openings absolutely watertight.

1.6 WEATHERPROOFING LOCATIONS (WP)

- A. Communication apparatus, such as outlet boxes, switches, connection panels, speakers, cameras, and other devices shall be weatherproof gasketed type, NEMA Types 3 or 4 in the following instances:
 - 1. On surface of exterior face of building, including areas where not under canopies, cast boxes with threaded hubs must be used and under canopies steel boxes with gasket connections to devices.
 - 2. In any areas where specifically noted "WP" or required by the NEC or Regulations mentioned herein.
 - 3. Within air conditioning enclosures.
 - 4. In underground splice boxes.
 - 5. On building roof.

1.7 CUTTING AND PATCHING

- A. Provide cutting and patching necessary to install the work specified herein. Patching shall match adjacent surfaces.
- B. No structural members shall be cut without prior approval of the Architect; such cutting shall be done in a manner directed by him.
- C. Provide ceiling removal and replacement where work above ceilings is required. Replace ceiling components damaged in the process.
- D. Provide patching where communications devices are removed from walls, ceilings or floors.

1.8 ACCESSIBILITY

- A. Coordinate to ensure the sufficiency of the size of shafts, and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.
- B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights, curtain tracks, speakers, and medical gas tracks. Equipment requiring access shall include, but is not necessarily limited to, motors, junction boxes, fire dampers, controllers, switchgear, etc.

- C. Indicate the locations of access doors for each concealed device, concealed behind finished construction and requiring service on the coordination drawings. Equipment below floor slab or finished grade shall also be indicated on the coordination drawings.
- D. Furnish access doors under this division for installation by General Contractor. Coordinate during bidding phase with General Contractor. Locations of access doors in finished construction shall be submitted in sufficient time to be installed in the normal course of the work.
 - 1. Manufacturers: Subject to compliance with requirements, furnish access doors by one of the following:
 - a. Bar-Co., Inc.
 - b. J. L. Industries
 - c. Karp Associates, Inc.
 - d. Nystrom, Inc.
 - 2. Materials and Fabrication:
 - a. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts and ready for installation.
 - b. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.
 - c. Frames: Fabricate from 16-gauge steel.
 - 1) Fabricate frame with exposed flange nominal 1 inch wide around perimeter of frame for units installed in the following construction:
 - a) Exposed Masonry
 - 2) For gypsum drywall or veneer gypsum plaster, furnish perforated frames with drywall bead.
 - 3) For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
 - 4) For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
 - d. Flush Panel Doors: Fabricate from not less than 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175°. Finish with manufacturer's factory-applied prime paint.
 - 1) For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.
 - e. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

1.9 PAINTING

- A. Painting requirements of this section shall conform to Section 099123 – Interior Painting.
- B. Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.
- C. Provide prime coat painting for the following:
 - 1. Indoor miscellaneous steel and iron provided under this Division of the specifications.
 - 2. Indoor hangers and supports provided under this Division of the specifications.

1.10 EQUIPMENT FOUNDATIONS, SUPPORTS, PIERS AND ATTACHMENTS

- A. Provide necessary foundations, auxiliary steel, supports, pads, bases and piers required for equipment specified in this division; submit drawings in accordance with Shop Drawing Submittal requirements prior to the purchase, fabrication or construction of same.
- B. Construction of foundations, supports, and pads where mounted on the floor, shall be of the same materials and same quality of finish as the adjacent and surrounding floor material.
- C. Equipment shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect, not strong enough shall be replaced as directed, with no additional cost to the Owner.

1.11 CLEANING, PROTECTING AND ADJUSTING

- A. Cleaning
 - 1. General cleaning requirements are specified in Division 01.
 - 2. Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed. Clean, polish, and leave equipment, accessories, and trim in first-class condition.
- B. Protection of Surfaces
 - 1. Protect new and existing surfaces from damage during the construction period.
 - 2. Provide plywood or similar material under equipment or materials stored on floors or roofs. Provide protection in areas where construction may damage surfaces.
 - 3. Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Owner and Architect.
- C. Protection of Services

1. Protect new and existing services from damage during the construction period.
2. Repair, replace, and maintain in service any new or existing utilities, facilities, or services (underground, overground, interior, or exterior) damaged, broken, or otherwise rendered inoperative during the course of construction.
3. Services damaged during the construction shall be replaced at the cost of the Contractor at fault. The method used in repairing, replacing, or maintain the services shall be approved by the Owner and Architect.

D. Protection of Equipment and Materials

1. Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
2. Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Architect or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.
3. During the construction period, protect equipment from damage and dirt.

E. Adjusting

1. After the entire installation has been completed, make required adjustments until performance requirements are met.

1.12 SPECIAL TOOLS

- A. Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

1.13 WELDING

A. General Requirements

1. This paragraph covers the welding of systems. Deviations from applicable codes, approved procedures and approved shop drawings shall not be permitted. Materials or components with welds made off the site shall not be accepted if the welding does not conform to the requirements of this specification. Develop and qualify procedures for welding metals included in the work. Certification testing shall be performed by an approved independent testing laboratory. Bear costs of such testing.
2. Certified welders, previously certified by test, may be accepted for the work without re-certification provided that all of the following conditions are fulfilled:
 - a. Submit copies of welder certification test records in accordance with this Division and Division 01 requirements.
 - b. Testing was performed by an independent testing laboratory.

- c. The welding procedures and welders are certified in accordance with the "ASME Boiler and Pressure Vessel Code," and base materials, filler materials, electrodes, equipment, and processes conform to the applicable requirements of this specification.
 - d. Certification has been within a one (1) year period from the start of the project.
- 3. Filler metals, electrodes, fluxes and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to assure safe handling.
- 4. Submit welding certificates for review. Each welder assigned to work covered by this specification shall be certified by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires.
- 5. Before assigning welders to the work, provide the architect with their names, together with certification that each individual is certified as specified. No welding work shall start prior to submissions. The certification shall state the type of welding and positions for which each is certified, the code and procedure under which each is certified, date certified, and the firm and individual certifying the certified tests.
- 6. Each welder shall be assigned an identifying number, letter, or symbol that shall be used to identify his welds. A list of the welders' names and symbol for each shall be submitted. To identify welds, either written records indicating the location of welds made by each welder shall be submitted, or each welder shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers shall be confined to the weld reinforcing crown, preferably in the finished crater.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 ENGINEERED THROUGH PENETRATION FIRESTOP SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Legrand Wiremold FlameStopper FS Series
 - 2. STI Firestop EZ-Path Series
 - 3. Hilti Speed Sleeve CP 653
- B. Classification and Use
 - 1. The fire-rated pathway shall contain a built-in fire sealing system sufficient to maintain the hourly fire rating of the barrier being penetrated. The self-contained sealing system shall adjust to the installed cable loading and shall permit cables to be installed, removed, or retrofitted without the need to remove or reinstall firestop materials.
 - 2. The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. UL Classification Mark.
 - 3. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4 1/2" (114mm) thick reinforced lightweight or normal weight (100-150 pcf) (1600-2400 kg/m3). The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.
 - 4. For retrofit applications where no conduit is installed in the wall to protect existing cables, split conduit assembly should be used to protect cables. After installing the split conduit within the wall, a wall plate should be installed to cover any irregularly shaped hole cut in the wall. The firestop device is then installed onto the conduit.

2.3 ENGINEERED SMOKE AND ACOUSTICAL SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. STI Firestop EZ-Path Smoke and Acoustical Pathway
 - 2. Hilti Speed Sleeve CP 653
- B. The smoke and acoustical sleeve shall be used to maintain an effective barrier against the spread of smoke and hot gases, and to restore the STC rating in through penetrations in non-fire rated wall and floor assemblies.
- C. The smoke and acoustical sleeve pathway shall permit cables to penetrate nonrated walls and floors without the need for smoke sealing. Cables shall be easily added or removed at any time without the need to remove or reinstall caulking materials.

2.4 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Coordinate piping systems installed at a required slope.
- F. Apply for detailed and specific information regarding the location of equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or

wiring improperly placed because of failure to obtain this information shall be relocated and re-installed without additional expense to the Owner. Determine the actual direction of door swings, so that local switches and other controls shall be installed at the lockside of doors, unless otherwise noted. Improperly located switches shall be relocated without additional expense to the Owner.

- G. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of outlets or equipment without written consent of the Architect and Owner.
- H. Unless otherwise mentioned or indicated, mounting heights of outlets are shown on the drawings or in the specification. Dimensions given shall be considered to be from center of outlet to finished floor.
- I. Coordinate the location and elevation of all communications devices and fixtures with the architectural interior elevation plan and reflective ceiling plan prior to installation.
- J. Properly rough in for the communications raceways and equipment under this contract and modify as required for coordination during the construction period.
- K. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- L. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 01 Section "Access Doors and Frames."
- M. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 01 Section "Penetration Firestopping."

3.2 WELDING

- A. Perform welding in accordance with qualified procedures using certified welders. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. Welding of hangers, supports, and plates to structural members shall conform to AWS specifications.
- B. Field bevels and shop bevels shall be by mechanical means or by flame cutting. Where beveling is by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding. Beveling shall conform to ANSI B31.1 and AWS B3.0.
- C. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening shall not be permitted. Welders responsible for defective welds must be re-certified.
- D. Store electrodes in a dry heated area, keep free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

3.3 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Communications penetrations occur when raceways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, fire-rated floor, or wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors
 - 1. Provide fabricated steel sleeves of diameter required for penetrations through walls and floors. Seal annular space between sleeve and wall, using joint sealant appropriate for size, depth, and location of joint.
 - 2. Provide re-enterable sealant suitable for cabling systems and plenum environments within the annular space between the sleeve and cabling bundle.
 - 3. Where shown on the drawings, provide Engineered Smoke & Acoustic Sleeves in lieu of fabricated steel sleeves to serve cable bundle penetrations through walls and floors.
- I. Fire-Rated-Assembly Penetrations
 - 1. Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations.
 - 2. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.
 - 3. Provide non-curing, re-penetrable, intumescent firestop materials around communications cable trays or ladder racks penetrating through a fire rated wall.
 - 4. Where shown on the drawings, provide Engineered Through Penetration Fire Stop Sleeves in lieu of fabricated steel sleeves to serve cable bundle penetrations through walls and floors.
- J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078413 - Penetration Firestopping.

3.6 DUST, DIRT AND NOISE

- A. Carry out new work and make changes, relocations, and installations with a minimum of noise. Site areas and new equipment, floors and walls, shall be adequately protected from dust and dirt caused by the work. Protection shall include suitable temporary barriers or coverings. The exterior and interior premises of each building shall be kept clean as possible during construction. Damages to surfaces or equipment as a result of negligence shall be replaced or corrected as required.

3.7 ENVIRONMENTAL AIR PLENUMS

- A. In spaces over hung ceiling which are used for environmental air handling purposes as defined by Article 300.22C of the National Electric Code, power data and communications cable must be in conduit or of the type cable rated for air plenum use. Cable type and/or raceway is generally indicated on the drawings and specifications although the Contractor shall be responsible to clearly define ceiling space used for environmental air purposes.

3.8 SPECIAL ENGINEERING SERVICES

- A. In the instance of complex or specialized telecommunications, security, and audiovisual systems that are included in Division 27; the installation, final connections, and testing of such systems shall be made under the direct supervision of competent authorized service engineers who shall be in the employ of the respective equipment manufacturer. Provide the Owner with copies of instruction manuals and booklets for each system and piece of equipment installed. Provide any additional instruction to the Owner over and above the listed above in the care, adjustment, and operation of all parts of the communications systems.

END OF SECTION 27 05 00

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding labeling.

1.3 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. PBB: Primary Bonding Busbar.
- C. SBB: Secondary Bonding Busbar.
- D. TGB: Telecommunications grounding busbar.
- E. TMGB: Telecommunications main grounding busbar.
- F. RBB: Rack Bonding Busbar
- G. RBC: Rack Bonding Conductor
- H. TEBC: Telecommunications Equipment Bonding Conductor
- I. TBB: Telecommunications Bonding Backbone
- J. TBC: Telecommunications Bonding Conductor
- K. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. Ground rods.
 - 2. Ground and roof rings.
 - 3. TBB, RBC, TEBC, TBC, RBB, PBB, SBBs, and routing of their bonding conductors.
- B. Qualification Data: For installer, installation supervisor, and field inspector.
- C. Qualification Data: For testing agency and testing agency's field supervisor.
- D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each SBB and PBB and its nearest grounding electrode.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of its Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a Registered Communications Distribution Designer (RCDD) to perform the on-site inspection.
- B. Comply with NFPA 70, National Electrical Code.

- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with ANSI/TIA-607-E Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises and BICSI Telecommunications Distribution Methods Manual, latest edition for grounding and bonding installation and methods.

2.2 CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Harger Lightning and Grounding
 - 2. Panduit Corp.
 - 3. Tyco Electronics Corp.
- B. Comply with UL 486A-486B.
- C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
- D. Cable Tray Grounding Jumper:
 - 1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
- E. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 1. Electroplated tinned copper, C and H shaped.
 2. Compression lugs for connections to PBB or SBB's shall be two-hole lugs with holes spaced at either 5/8 inch or 1 inch according to size of grounding conductor.
 3. Provide stainless steel hardware complete with bolt, nut, and lock washer to fasten the two-hole ground lugs to the busbar.
 4. Manufacturers: Subject compliance with requirements, provide products by one of the following.
 - a. Burndy
 - b. Chatsworth Products, Inc.
 - c. Erico Eritech
 - d. Harger Lightning and Grounding
 - e. Panduit Corp.
 - f. Tyco Electronics Corp.
 5. Provide one-hole compression lugs to grounding conductors attached to telecommunications equipment including but not limited to equipment racks, frames, cable tray, conduit, lightning protectors, and other components as required. Where attachment is made to painted surfaces, remove paint to provide bright clean surface for bonding or provide paint piercing washers.
- C. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. PBB
 - a. Erico Eritech model TMGB-A18L23PT
 - b. Chatsworth Products, Inc.
 - c. Panduit Corp.
 2. SBB
 - a. Erico Eritech model TGB-A18L10PT
 - b. Chatsworth Products, Inc.
 - c. Panduit Corp.
 3. RBB
 - a. Chatsworth 10610-019 with hardware kit
 - b. Erico
 - c. Panduit
- B. PBB (Primary Bonding Busbar): Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as PBB and shall comply with TIA-607-D.
1. Predrilling shall be with holes for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. SBB (Secondary Bonding Busbar): Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-D.
1. Predrilling shall be with holes for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
- D. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

- E. Rack Bonding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-D. Predrilling shall be with holes for use with lugs specified in this Section.

- 1. Rack-Mounted Horizontal Busbar: Designed for mounting in 19in. or 23in. equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet in diameter.

2.6 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brother International Corporation.
 - 2. HellermannTyton.
 - 3. Panduit Corp.
- C. Comply with ANSI/TIA-606-D and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- D. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others. Bond all telecommunications equipment.
- B. Comply with NECA 1.
- C. Comply with TIA-607-E Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises and BICSI Telecommunications Distribution Methods Manual, latest edition for grounding and bonding installation and methods.

3.3 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the SBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the PBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Connections to Structural Steel: Bolted connectors.
- C. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- D. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.

4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a PBB or SBB.
- E. The minimum TBB conductor size shall be a 6 AWG. The TBB should be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 750 kcmil. The TBC shall be, as a minimum, the same size as the largest TBB. The BBC shall be, as a minimum, the same size as the largest TBB to which it is connected. The minimum SBC size shall be the greater of 6 AWG or the largest conductor bonded to the associated SBB. Refer to the table below for requirements.

TBB/BBC linear length m (ft)	Conductor size (AWG)
less than 4 (13)	6
4 – 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8 – 10 (27 – 33)	2
10 – 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

3.4 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

3.5 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Interconnections: Interconnect all SBBs with the PBB with the telecommunications backbone conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- E. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the PBB/SBB No. 2 AWG bonding conductors.
- F. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each SBB and PBB to the vertical steel of the building frame.
- G. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each SBB to the ground bar of the panelboard.
- H. Shielded Cable: Bond the shield of shielded cable to the SBB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- I. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.6 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label PBB/SBB(s) with "fs-PBB" or "fs-SBB" where "fs" is the telecommunications space identifier for the space containing the SBB.
 - 2. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Test the bonding connections of the system using an AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a PBB and a SBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 - 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the PBB and in each SBB. Maximum acceptable ac current level is 1 A.
- D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 27 05 26

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Optical-fiber-cable pathways and fittings.
 - 4. Metal wireways and auxiliary gutters.
 - 5. Nonmetallic wireways and auxiliary gutters.
 - 6. Metallic surface pathways.
 - 7. Nonmetallic surface pathways.
 - 8. Boxes, enclosures, and cabinets.
 - 9. Polymer-concrete handholes and boxes for exterior underground cabling.
- B. Provide raceways as required for the following low voltage systems:
 - 1. Data/Voice/Video Premise Wiring System
 - 2. Audiovisual Cabling Systems
 - 3. Security Systems

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.
- E. EMT: Electrical Metallic Tubing
- F. BICSI: Building Industry Consulting Service International.
- G. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.

- H. EMI: Electromagnetic interference.
- I. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.4 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface raceways.
 - 2. Wireways and fittings.
 - 3. Boxes, enclosures, and cabinets.
 - 4. Underground handholes and boxes.
- B. Shop Drawings: For custom enclosures and cabinets . Include plans, elevations, sections, and attachment details.

1.5 SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
 - 3. Underground ducts, piping, and structures in location of underground enclosures and handholes.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Data: Seismic rating for all pathway racks, enclosures, cabinets, equipment racks, and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.
- D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. Manufacturers
 - 1. AFC Cable Systems
 - 2. Allied Tube & Conduit
 - 3. Thomas & Betts Corporation
 - 4. Wheatland Tube Company
- C. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. ARC: Comply with ANSI C80.5 and UL 6A.
- F. IMC: Comply with ANSI C80.6 and UL 1242.
- G. PVC-Coated Steel Conduit: PVC-coated GRC.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- H. EMT: Comply with ANSI C80.3 and UL 797.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use

to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.
- B. Manufacturers
 - 1. Carlon
 - 2. Dura-Line
 - 3. Lamson & Sessions
 - 4. RACO; Hubbell
 - 5. Thomas & Betts Corporation
- C. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. Rigid HDPE: Comply with UL 651A.
- F. Continuous HDPE: Comply with UL 651A.
- G. RTRC: Comply with UL 2515A and NEMA TC 14.
- H. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.
- I. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Manufacturers
 - 1. Refer to related Division 27 sections for additional requirements. Provide innerduct where indicated on the drawings.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Innerduct Raceway:
 - 1) Endot Industries, Inc
 - 2) Carlon: Lamson & Sessions Company
 - 3) Eastern Wire & Conduit: Tyco International LTD

4) Duraline

B. Plenum Rated Innerduct Raceway

1. Construction: Flexible corrugated design manufactured from PVDF resin. Innerduct shall not kink under normal usage and installation. Innerduct shall be colored orange with sequential footmarks.
2. Electrical Properties:
 - a. Dielectric strength: 541 v/mil complying with ASTM D149.
 - b. Dielectric Constant @ 5MHz: 5.2 complying with ASTM D150.
3. Fire Resistance shall comply with UL Standard 2024, UL Test 910.
 - a. Maximum Flame Propagation: 1.50 ft.
 - b. Peak Optical Smoke Density: 0.06
 - c. Average Optical Smoke Density: 0.01
 - d. Oxygen Index: 63% complying with ASTM D2863
 - e. Flame Rating: S-E complying with ASTM D2863
 - f. UL Classification: V-O complying with UL 94
4. Innerduct shall be supplied with UL listed plenum rated Kevlar tape in the raceway for pulling cable.
5. Innerduct shall meet or exceed all Underwriter Laboratories requirements for installation in plenum areas.
6. Innerduct shall not be split for side entry and shall be of standard wall thickness.

C. Riser Rated Innerduct Raceway

1. Construction: Flexible corrugated nonmetallic design manufactured from nylon resin and is non-halogenated. Innerduct shall not kink under normal usage and installation. Innerduct shall be colored white with sequential footmarks.
2. Mechanical Properties:
 - a. Tensile strength, yield: 7,800 PSI complying with ASTM D638.
 - b. Flexural Strength: 9,200 PSI complying with ASTM D790.
3. Thermal Properties: Melting point of 420°F complying with ASTM D789.
4. Fire resistance shall comply with UL Standard 2024
 - a. Maximum Flame Propagation: 4.25 ft.
 - b. Maximum Damage Height: 6.75 ft
5. Innerduct shall be supplied with UL listed riser rated Kevlar pull tape or cable in raceway for pulling cable.
6. Innerduct shall meet or exceed all Underwriters Laboratories requirements for riser installations and shall conform to NEC Article 770.53.
7. Innerduct shall not be split for side entry and shall be of standard wall thickness.

- D. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum installation unless otherwise indicated.

- E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- F. Comply with TIA-569-D.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. General Requirements for Metal Wireways and Auxiliary Gutters:
 - 1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.
- B. Finish: Color selected by Architect.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.6 SURFACE NONMETALLIC PATHWAYS:

- A. Manufacturers:
 - 1. Wiremold / Legrand 5400 nonmetallic raceway
- B. Surface nonmetallic raceway is to be utilized in dry interior locations only as defined in Article 388 of the National Electrical Code, as adopted by the National Fire Protection Association and approved by the American National Standards Institute.

- C. It shall comply with TIA/EIA 569-A Commercial Building Standards for Telecommunications. The 5400 Raceway System has a 600V rating for power applications.
- D. The raceway and all system components must be composed of UL Listed materials and exhibit nonflammable self-extinguishing characteristics, tested to comparable specifications of UL94V-0.
- E. The raceway base and cover shall be manufactured of rigid PVC compound, available in ivory or white.
- F. The raceway shall be a two-piece design with a base and snap-on covers. The raceway base shall accept both a single cover that spans the entire base or two individual TwinSnap™ covers. Total width shall be 5.25" by 1.75" deep with an approximate thickness of .095". The base and cover shall be available in 8' lengths. The raceway shall be available with two or three wiring channels.
- G. The two channel base shall have two wiring channels separated by one integral barrier. Each channel must be large enough to accept standard power and communication devices without restricting capacity of the adjacent channel. The three channel base shall have three wiring channels separated by two integral barriers forming 1/2, 1/4, and 1/4 compartments. One channel must be large enough to accept standard power and communication devices without restricting capacity of the other channels.
- H. A complete line of full capacity corner elbows and tee fittings must be available to maintain a controlled 2" cable bend radius which meets the specifications for Fiber Optic and UTP/STP cabling and exceeds the TIA/EIA 569-A requirements for communications pathways. They shall be manufactured of a rigid PVC compound.
- I. A full complement of fittings must be available including, but not limited to tees, entrance fittings, cover clips, and end caps. They shall be manufactured of a rigid PVC compound. The fittings shall have a matte texture, in ivory or white colors to match the base and cover. They shall overlap the cover and base to hide uneven cuts. All fittings shall be supplied with a base where applicable to eliminate mitering. A transition fitting shall be available to adapt to other Wiremold series raceways.
- J. Device brackets shall be available for mounting standard devices in-line or offset from the raceway. A device bracket shall provide up to three single-gang openings at one location. Faceplates shall be 5507 Series that match and fit flush in the device plate. They shall be manufactured of rigid PVC compound.
- K. The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP, STP (150 ohm), fiber optic, coaxial and other cabling types with faceplates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons, as well as write-on station identification labels shall be available.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.

B. Manufacturers

1. Hoffman; a brand of Pentair Equipment Protection
2. RACO; Hubbell
3. Thomas & Betts Corporation
4. Wiremold / Legrand

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep
5. Gangable boxes are prohibited unless otherwise noted.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.

H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4, or Type 12, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:
 - a. Material: Plastic or Fiberglass.
 - b. Finished inside with radio-frequency-resistant paint.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

J. Cabinets:

1. NEMA 250, Type 1, Type 3R. or Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 OPEN TOP CABLE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Non-continuous Cable Supports (J-Hooks)
 - a. Erico
 - b. Thomas & Betts
 - c. B-Line
- B. Non-continuous cable supports and cable support assemblies shall be listed by Underwriters Laboratories for both Canadian and US standards (cULus).
- C. Non-continuous cable supports shall have the manufacturers name and part number stamped on the part for identification.
- D. Construction
 1. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
 2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 3. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
 4. Non-continuous cable supports shall be rated for indoor use in non-corrosive environments.
- E. Multi-Tiered Non-Continuous Cable Supports Assemblies
 1. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; cULus Listed.
 2. If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
- F. Non-Continuous Cable Support Assemblies from Beam, Flange
 1. Fastener to C to Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.

- G. Non-Continuous Cable Support Assemblies from C & Z Purlin
 - 1. Fastener to C to Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.
- H. Non-Continuous Cable Support Assemblies from Wall, Concrete, or Joist
 - 1. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
- I. Non-Continuous Cable Support Assemblies from Threaded Rod
 - 1. Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
 - 2. The multi-tiered support bracket shall have a static load limit of 300 lbs.
- J. Installation Accessories for Non-Continuous Cable Supports
 - 1. Non-continuous cable supports may be used as an installation tool when a removable pulley assembly is included. The pulley shall be made of plastic and be without sharp edges. The pin and bail assembly must be able to be secured to the J-Hook during cable installation. The pulley must remain secured while cables are being pulled.
 - 2. The pin and roller assembly must be removed after cables are installed.
- K. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- L. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- M. Comply with TIA-569-D.
- N. Galvanized steel.
- O. J shape.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: IMC.
 - 3. Underground Conduit: Type EPC-40-PVC.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R, Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: IMC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway, EMT.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway, EMT.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway, Riser-type, optical-fiber-cable pathway, Plenum-type, optical-fiber-cable pathway, EMT.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in damp or wet locations.

C. Minimum Pathway Size: 1 inch for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.

3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
-
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
 - C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
 - D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
 - E. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
 - F. Complete pathway installation before starting conductor installation.
 - G. Contractor shall size conduit large enough to accommodate at least 50% growth. I.e. conduit for 4 cables shall be sized to accommodate 6 cables at less than 40% calculated fill based on cable OD.
 - H. Interior cable pathways shall utilize 4 inch conduits as connecting points to the communications rooms unless space constraints prevent installation.
 - I. Additional conduit to the communications rooms shall be installed to provide a 4 to 1 ratio of 40% full conduit to a single empty conduit for future use.
 - J. Coordinate exact location of backboxes with Architectural drawings prior to installation of raceways and backboxes and before construction of walls and floors.
 - K. Recessed wall outlet backboxes shall be double ganged, 4 11/16" x 4 11/16" x 2 1/8" minimum size. Provide trim ring on outlet box as required for specific wall construction and size of faceplate.
 - L. Do not install any Division 27 raceway or conduit below slab on grade unless shown or stated otherwise or approved by the Engineer.
 - M. Each telecommunication system wall outlet shall have a dedicated outlet box and not be ganged together with power receptacles unless otherwise stated.
 - N. Do not "daisy-chain" conduit between outlet back boxes for data/voice/video systems unless otherwise stated in specific cases.
 - O. Coordinate the length and routing of raceway runs to meet cabling length requirements of TIA/EIA 568/569 Standards.
 - P. Arrange stub-ups so curved portions of bends are not visible above finished slab.

- Q. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- R. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- S. Support conduit within 12 inches of enclosures to which attached.
- T. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from nonmetallic conduit and fittings to RNC and fittings before rising above floor.
- U. Stub-ups to Above Recessed Ceilings (only where exposed cable installation is permitted):
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- V. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- W. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- X. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- Y. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- Z. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- AA. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

- BB. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- CC. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- DD. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- EE. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- FF. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- GG. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- HH. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- II. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- JJ. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- KK. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- LL. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- MM. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- NN. Set metal floor boxes level and flush with finished floor surface.
- OO. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 OPEN TOP CABLE SUPPORTS

- A. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.

- B. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
- C. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
- D. Space hooks no more than 5 feet o.c.
- E. Provide a hook at each change in direction

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078400 "Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems for communication raceways.
 - 2. Aluminum slotted support systems for communication raceways.
 - 3. Nonmetallic slotted support systems for communication raceways.
 - 4. Conduit and cable support devices.
 - 5. Support for conductors in vertical conduit.
 - 6. Structural steel for fabricated supports and restraints.
 - 7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
 - 8. Fabricated metal equipment support assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.
 - 1. Trapeze hangers. Include product data for components.
 - 2. Steel slotted-channel systems.
 - 3. Aluminum slotted-channel systems.
 - 4. Nonmetallic slotted-channel systems.
 - 5. Equipment supports.
- C. Delegated-Design Submittal: For hangers and supports for communications systems.
 - 1. Include design calculations and details of trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Ductwork, piping, fittings, and supports.
 - 3. Structural members to which hangers and supports will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M.
 - 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified"
 - 2. Component Importance Factor: 1.0.
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Material for Channel, Fittings, and Accessories: Galvanized steel
 - 3. Channel Width: 1-5/8 inches
 - 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 - 8. Channel Dimensions: Selected for applicable load criteria.
- B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Channel Material: 6063-T6 aluminum alloy.
 - 3. Fittings and Accessories Material: 5052-H32 aluminum alloy.

4. Channel Width: 1-5/8 inches.
 5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 8. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c., in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 2. Channel Width: 1-5/8 inches.
 3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 4. Fitting and Accessory Materials: Same as those for channels and angles[, except metal items may be stainless steel.
 5. Rated Strength: Selected to suit applicable load criteria.
 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and RMC may be supported by openings through structure members, according to NFPA 70.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Use expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 Painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 27 05 29

SECTION 27 05 34 FLOOR BOXES FOR ELECTRICAL AND COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE

- A. The floor box provides the interface between power and communication cabling in a concrete floor, and the workstation where both power and communication device outlets are required. The box provides recessed device outlets that will not obstruct the floor area.
- B. These poke-thru devices provide the interface between power, communication and audio/ visual (A/V) cabling in an above grade concrete floor and the workstation or activation location where power communication and/or A/V device outlets are required. These poke-thru devices provide recessed device outlets that will not obstruct the floor area.

1.3 CLASSIFICATION AND USE

- A. The floor box shall be approved for use on above-grade concrete floors and on-grade with a vapor barrier. The floor box shall be examined and tested by Underwriters Laboratories Inc. to their Standard UL514A and bear the listing mark. The floor box shall conform to the standards set in the National Electrical Code. The floor box shall also have been evaluated by UL to meet the applicable U.S. standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
- B. This poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to Standard UL514A and/or UL514C and Canadian Standard C22.2, No. 18-98 and bear the U.S. and Canadian UL Listing Mark.
- C. This poke-thru device shall also have been tested by Underwriters Laboratories Inc. and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. Devices shall be classified for use in 1-, 1 1/2-, or 2-hour rated, unprotected reinforced concrete floors and 1-, 1 1/2-, or 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series Designs) or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the poke-thru fittings).
- D. This device shall also conform to the standards set in the National Electric Code, Section 300-21. These devices meet all UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens.

- E. This poke-thru device shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors. Suitable for use in air handling spaces in accordance with Sec 300-22 (C) of the National Electrical Code.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Subject to compliance with requirements, provide:

1. Poke Through "Type A"

- a. Wiremold Evolution 8STCP, FSR, or Hubbell.

1) Top Plates:

- a. Compartment 1: 68REC - Two (2) proprietary 20AMP duplex power receptacles with mounting plates.
- b. Compartment 2: 68REC - Two (2) proprietary 20AMP duplex power receptacles with mounting plates.
- c. Compartment 3/4/5: 8DEC - Single gang device plate with decora style adapter for telecommunications and audiovisual devices.

2) Bottom Plates:

- a. Compartment 1: 5BLH - Exterior-gang blanking assembly.
- b. Compartment 2: 575CHA - Exterior-gang 3/4" trade size conduit service feed assembly for power connections.
- c. Compartment 3: 10125CHA - Exterior-gang 1 1/4" trade size conduit service feed assembly for telecommunications connections.
- d. Compartment 4/5: 2210CHA - Center-gang 2" trade size conduit service feed assembly for audiovisual connections.

3) Cover: 8CTC2xx, Surface Style, powder coat finish color selected by Architect.

2. Poke Through "Type B"

- a. Wiremold Evolution 6STCP, FSR or Hubbell.

1) Top Plates:

- a. Outer Compartment 1: 68REC - Two (2) proprietary 20AMP duplex power receptacles with mounting plates.
- b. Center Compartment: 6DEC - Single gang device plate with decora style adapter for telecommunications devices.

- c. Outer Compartment 2: 68REC - Two (2) proprietary 20AMP duplex power receptacles with mounting plates.
 - 2) Bottom Plates:
 - a. Outer Compartment 1: 5BLH - Half-gang blank housing assembly.
 - b. Center Compartment: 1125CHA - Exterior-gang 1 1/4" trade size conduit service feed assembly.
 - c. Outer Compartment 2: 575CHA - Half-gang 3/4" trade size conduit housing assembly.
 - 3) Cover: 6CTC2xx, Surface Style, powder coat finish color selected by Architect.
- 3. Poke Through "Type C"
 - a. Hubbell Wiring Device Kellems S1R4PTQUADxxx, Wiremold, or FSR, cover finish color selected by Architect.
- 1) Subplate: pre-wired quad receptacle with mounting plate

2.2 POKE THROUGH "TYPE A"

A. Poke-Thru Assembly

- 1. Poke-thru device assemblies shall consist of an insert and an activation cover. Assembly length: 11-3/4 inches.
- 2. Insert: Insert body shall recess the devices a minimum of 4-1/2 inches and have a polyester based backing enamel finished interior; ivory color. Furnish with necessary channels to provide complete separation of power, communication, and audio/video (A/V) services. Provide eight (8) compartments (four (4) internal and four (4) external). The four (4) internal compartments shall have a volume of 19 cu in each. The four (4) external compartments shall have a minimum volume of 14 cu in each.
- 3. Body consists of an intumescent firestop material to maintain fire rating of the floor slab. Hold intumescent material securely in place in insert body. Intumescent material will not have to be adjusted to maintain fire rating of the unit and the floor slab. Provide insert with a retaining feature to hold the poke-thru device in the floor slab without additional fasteners. The intumescent body shall be listed and classified as an electrical enclosure allowing for electrical connections to be made within the poke-thru body without the need for an external junction box.

- B. Activation Cover: Manufactured of die-cast aluminum alloy; Provide with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub water tightness. Activation cover is 11-1/4 inches in diameter. Provide cover with spring-loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.

- C. Communication Modules Mounting Accessories: Provide activation unit with mounting bracket capable of accepting Category 6 insert modules or Category 6 discrete keystone connectors. Fabricate mechanism from stamped steel construction. Mechanism shall accept both flexible and rigid 3/4-inch, 1-1/4-inch or two-inch trade size conduit.

2.3 POKE THROUGH "TYPE B"

- A. Poke-thru device assemblies shall consist of an insert and an activation cover. Assembly length: 16-3/4 inches.
- B. Insert: Insert body shall recess the devices a minimum of 2-3/4 inches (69mm) and have a polyester based backing enamel finished interior; ivory color. Furnish with necessary channels to provide complete separation of power and communication services. Provide three (3) compartments that allow for duplex receptacles, communication ports and/or audiovisual devices.
- C. Body consists of an intumescent firestop material to maintain fire rating of the floor slab. Hold intumescent material securely in place in insert body. Intumescent material will not have to be adjusted to maintain fire rating of the unit and the floor slab. Provide insert with a retaining feature to hold the poke-thru device in the floor slab without additional fasteners. Poke-thru insert shall also consist of a 3/4-inch trade size conduit stub that is connected to the insert body and a 24.5 cu in stamped steel junction box for wire splicing and connections. Stamped steel junction box shall also contain the means necessary to electrically ground the poke-thru device to the system ground.
- D. Activation Cover: Manufactured of die-cast aluminum alloy; finished powder-coated. Provide with two (2) gaskets (one (1) for surface and one (1) for flush) to go under the trim flange to maintain scrub water tightness. Activation cover is 7-1/4 inches in diameter. Provide cover with spring-loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.
- E. Communication Modules Mounting Accessories: Provide activation unit with connectors using a mounting bracket capable of accepting Category 6 insert modules or Category 6 discrete keystone connectors. Fabricate mechanism from stamped steel construction. Mechanism shall accept both flexible and rigid 3/4-inch, 1-1/4-inch or two-inch trade size conduit.

2.4 POKE THROUGH "TYPE C"

- A. Standards
 - 1. cULus & ULC Listed
 - 2. UL scrub water compliant
 - 3. ADA Compliant
- B. Specifications

- C. Cover load rating 1000 lbs. static load through 3" diameter mandral
 - 1. Access cover material - die cast aluminum
 - 2. Fire Rating 1 - 2 Hour Fire Rating

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Poke Throughs
 - 1. The poke through use is defined by the UL Fire Resistance Directory as a minimum spacing of 2 ft. [610mm] on center and not more than one device per each 65 sq. ft. [6m²] of floor area in each span."
 - 2. Installation shall be completed by pushing unit down into the cored hole. Prior to and during installation, refer to system layout and/or approval drawings. Installer shall comply with detailed manufacturer's instruction sheet included with each device. The unit shall contain a retainer for securing the device in the slab, as well as the necessary intumescent material to seal the cored-hole under fire conditions.
 - 3. Provide conduits to the poke throughs for various services as required.
 - 4. Field verify final location of all poke throughs.
 - 5. Provide lid activation covers of type, finish, and configuration as required. Final configuration shall be approved by the Architect.
 - 6. Provide additional supplemental support for the poke through as needed to securely set it at the proper elevation.
 - 7. The contractor shall identify the final finished floor type prior to installation. Consult with the manufacturer for directions and elevations for installing the floor box with that type of floor finish. Provide the complete installation as required for that finished floor type.
 - 8. Provide device brackets for mounting power and communications devices and jacks. Coordinate with the Architect for the final configurations and types required for each floor box. The Contractor shall provide any configuration and type required.
 - 9. Provide activation covers for every poke through. Coordinate with the Architect for the final lid configuration and type required for each floor box. The contractor shall provide any configuration and type required.

3.2 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Protect boxes until acceptance.

END OF SECTION 27 05 34

SECTION 27 05 36 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Wire-mesh cable tray.
 - 2. Cable tray accessories.
 - 3. Warning signs.

1.3 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code (NEC).
- B. ASTM International (ASTM):
 - 1. ASTM A 123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A 380 - Specification for Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - 3. ASTM A 510 - Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
 - 4. ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
 - 5. ASTM B 633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - 6. ASTM C 3451 - Specification for Powder Coated Painted Tray.
 - 7. ASTM F 1136 - Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners.
 - 8. IEC 61537 - Cable Tray Systems and Cable Ladder Systems for Cable Management.
 - 9. NEMA VE 1/CSA C22.2 No. 126.1-02 - Metal Cable Tray Systems.
 - 10. NEMA VE 2 - Metal Cable Tray Installation Guidelines.
 - 11. TIA 569-A (1998) - Commercial Building Standard for Telecommunications Pathways and Spaces.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of cable tray.
 - 1. Include data indicating dimensions and finishes for each type of cable tray indicated.
- B. Shop Drawings: For each type of cable tray.
 - 1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
 - 2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 2. Vertical and horizontal offsets and transitions.
 - 3. Clearances for access above and to side of cable trays.
 - 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Seismic Qualification Data: Certificates, for cable trays, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Certified by manufacturer.

1. Certified Installers: Cable tray installers shall have successfully completed Manufacturer's Installer program.

B. Product Requirements:

1. Source Limitations: Obtain cable tray components through one source from a single manufacturer.
2. Approval and Labeling: Provide cable trays and accessories specified in this Section that are approved and labeled.
 - a. The Terms "Classified" pertaining to cable trays (rather than "Listed") and "Labeled": As defined in NFPA 70, Article 100.
 - b. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
3. Comply with NFPA 70, National Electrical Code, Article 392: Cable Trays; provide UL Classification and labels.
4. Comply with IEC 61537, Cable Tray Systems and Cable Ladder Systems for Cable Management.
5. Comply with NEMA VE 1/CSA C22.2 No. 126.1, Metal Cable Tray Systems, for materials, sizes, and configurations; provide cCSAus Certificate and labels.
6. Provide documentation of the following certifications:
 - a. ISO 9001 quality certification.
 - b. American Bureau of Shipping (ABS) Product Design Assessment certification.
 - c. Det Norske Veritas (DNV) certification.
 - d. E 90 Fire Testing certification.
7. Provide UL (or ETL) test documentation showing cable compression/deformation testing.
8. Provide military test documentation showing compliance with the following standards:
 - a. MIL-S-901D (Navy) - Military Specification, Requirements for Shock Tests, High Impact; Shipboard Machinery, Equipment and Systems
 - b. MIL-STD-167-1 (Ships) - Military Standards Mechanical Vibrations of Shipboard Equipment
9. Structural Performance: Cable trays shall be tested and rated for load carrying capacity and safety factors.
 - a. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - b. Concentrated Load: A load applied at midpoint of span and centerline of tray.

- c. Load and Safety Factors: Applicable to both side rails and rung capacities.
- C. Mock-Up: Provide a mock-up for evaluation of installation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship is approved by Architect.
 - 3. Rework mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Avoid breakage, denting and scoring finishes. Damaged products shall not be installed. Store cable trays and accessories in original cartons and in clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 COORDINATION

- A. Coordinate layout and installation of cable tray with other installations.
 - 1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Architect.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. B-Line Flextray
 - 2. Cablofil
 - 3. Cope Cable tray
 - 4. WBT Tray

2.2 GENERAL REQUIREMENT FOR CABLE TRAY

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 - 1. Source Limitations: Obtain cable trays and components from single manufacturer.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-MESH CABLE TRAY

- A. Cable tray shall consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC). Wire mesh cable tray will have continuous T-welded top side wire to protect cable insulation and installers.
 - 1. Cable tray systems shall include, but are not limited to, straight sections, supports and accessories.
 - 2. Provide splices, supports, and other fittings necessary for a complete, continuously grounded system.
 - a. Mesh: 2 by 4 inches.
 - b. Straight Section Lengths: 118 inches.
 - c. Wire Diameter: Patented design includes varying wire sizes to meet application load requirements; to optimize tray strength; and to allow tray to remain lightweight.
 - d. Fittings: Wire mesh cable tray fittings shall be field-fabricated from straight tray sections, in accordance with manufacturer's instructions.
 - e. Tape: Painted wire mesh cable tray to include metallic conductive UL tape.
 - 3. Wire-Basket Depth: 4-inch usable loading depth, unless otherwise indicated on the drawings.
 - 4. Length: Cable tray section length shall be 118.1 inches unless otherwise shown on drawings.
 - 5. Cable Tray Material: Carbon steel wire, ASTM A 510, Grade 1008. Wire welded, bent, and surface treated after manufacture.
 - a. Electrodeposited Zinc Plating: ASTM B 633, Type III, SC-1.

6. Load Span Criteria:
 - a. Install and support cable management system in accordance with NEMA VE-1, with Safety Factor of 1.5.
7. Fittings/Supports: Wire mesh cable tray fittings are field-fabricated from straight tray sections, in accordance with manufacturer's instructions. Supports shall include the FAS (Fast Assembly System) where possible so that screws, bolts, and additional tools are not required for cable tray mounting to reduce installation time; and tray path can adapt to installation obstacles without the need for additional parts. Place supports so that support span does not exceed that shown on the drawings and is capable of supporting total fill capacity loading.
 - a. Ceiling-mounted supports mount to ceiling structure directly or with threaded rod sized for total fill capacity.
 - b. Wall-mounted supports.
 - c. Splices, including those approved for electrical continuity (bonding), as recommended by cable tray manufacturer.
8. Cable tray shall consist of continuous, rigid, welded steel wire mesh cable management system, to allow continuous ventilation of cables and maximum dissipation of heat, with UL Classified splices where tray acts as Equipment Grounding Conductor (EGC).
 - a. Cable tray systems shall include, but are not limited to, straight sections, supports and accessories.
 - b. Configuration: Wires are formed into a standard 2 inches by 4 inches (50 by 100 mm) wire mesh pattern with intersecting wires welded together. Mesh sections shall have at least one bottom longitudinal wire along entire length of section.
 - c. Materials: High-strength-steel longitudinal wires with "T" weld.
 - d. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
 - e. Straight sections shall be furnished in standard 118.1 inches lengths.
9. Connector Assemblies: Listed Snap in couplers or factory assembled bolted couplers that mechanically join adjacent tray wires to splice sections together or to create horizontal fittings.
10. Hardware and Fasteners:
 - a. ASTM F 593 and ASTM F 594 stainless steel, Type 316.
 - b. Steel, zinc plated according to ASTM B 633.
11. Steel Material: Straight section and fitting side rails and rungs shall comply with the minimum mechanical properties of ASTM A 1008/A 1008M.
12. Steel Tray Splice Plates: ASTM A 1008/A 1008M.
13. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
14. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

- A. Comply with requirements for identification in Section 270553 "Identification for Communications Systems."
- B. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA VE 2.
- B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure.
- G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

- H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- I. Support bus assembly to prevent twisting from eccentric loading.
- J. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
- K. Support wire-basket cable trays with trapeze hangers and wall brackets.
- L. Support trapeze hangers for wire-basket trays with 3/8-inch- (10-mm-) diameter rods.
- M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.
- N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
- O. Make changes in direction and elevation using manufacturer's recommended fittings.
- P. Make cable tray connections using manufacturer's recommended fittings.
- Q. Seal penetrations through fire and smoke barriers.
- R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.
- S. Install cable trays with enough workspace to permit access for installing cables.
- T. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

- D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 27 05 36

SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Provide a cable plant labeling system that will allow the Owner to easily identify the origin and destination of each and every cable and outlet installed under this contract. The section includes minimum requirements for the following:
 - 1. Labeling technology cabling.
 - 2. Labeling technology hardware and equipment.
 - 3. Labeling work station outlets and faceplates.
 - 4. Labeling technology pathways.
 - 5. Labeling technology spaces.
 - 6. Labeling technology grounding and bonding components.
- B. Station cables, riser cables, pull boxes, and conduit runs must be labeled at both ends for easy identification. No handwritten labels will be permitted.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, and accessories.
- B. Labeling Nomenclature: Labeling schemes and nomenclature for each component of the telecom systems designated to be labeled.

1.4 QUALITY ASSURANCE

- A. Identification and administration work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA-568.0-E (March 2020) Generic Telecommunications Cabling for Customer Premises
 - 2. ANSI/TIA-568.1-E (March 2020) Commercial Building Telecommunications Infrastructure Standard
 - 3. ANSI/TIA-568.2-D (September 2018) Balanced Twisted Pair Communications and Components Standards
 - 4. ANSI/TIA-568.4-E (July 2022) Broadband Coaxial Cabling and Components Standard
 - 5. ANSI/TIA-569-E (May 2019) Telecommunications Pathways and Spaces
 - 6. ANSI/TIA-606-D (October 2021) Administration Standard for Telecommunications Infrastructure
 - 7. ANSI/TIA-607-D (July 2019) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

8. Telecommunications Distribution Methods Manual, 14th Edition
9. UL 969.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Brady
 2. Panduit

2.2 CABLING LABELS

- A. Cable labels shall be pressure sensitive labels with non-smearing printing.
- B. The labels shall be long lasting adhesive type.
- C. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.
- D. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.
- E. Provide vinyl substrate with a white printing area and black print. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow, so that the labels are easily distinguishable.
- F. Shall be flexible vinyl or other substrates to apply easy and flex as cables are bent.
- G. Shall use aggressive adhesives that stay attached to all cable insulation types.
- H. Cabling labels shall be generated with laser printers.
- I. Physical dimensions of cabling labels provided shall correspond to type of cable. Provide label sizes for various cables as recommended by the manufacturer.

2.3 TECHNOLOGY HARDWARE AND EQUIPMENT IDENTIFICATION LABELS

- A. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.
- C. Where insert type labels are used, provide clear plastic cover over label.

2.4 GROUNDING AND BONDING, PATHWAY, AND SPACE LABELS

- A. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.

2.5 WORKSTATION LABELS

- A. Shall meet the legibility, defacement, exposure, and adhesion requirements of UL 969.

- B. Shall be preprinted or computer printed type. Handwritten labels are not acceptable.
- C. Where insert type labels are used, provide clear plastic cover over label.

PART 3 - EXECUTION

3.1 CABLE LABELING

- A. Label each end of each cable with its identification number prior to pulling. Locate labels at a location which will not be mutilated or destroyed when cables are dressed for terminal installation.
- B. Horizontal and Backbone Cables shall be marked within 12 inches of each endpoint.
- C. Any cable installed in conduit shall be labeled at all intermediate pull or junction boxes.
- D. Label cables using the appropriate circuit ID.
- E. Use adhesive type labels for all communications cable labels.
- F. Affix labels to cables – marking cable is not permitted.
- G. Label both ends of each patch cord provided as part of the system.

3.2 LABELING OF PATCH PANELS

- A. Station cables shall terminate (on 110 Blocks) in the telecommunications closet on the same floor as the station jacks (unless otherwise noted).
- B. 110 Blocks
 - 1. Each cable termination position on 110 blocks shall be labeled with number designators.
 - 2. For 110 blocks where insert type labels are used, install clear plastic cover over preprinted or laser printed type label.

3.3 LABELING OF THE WORKSTATION OUTLETS

- A. Outlets shall be labeled per the Owner's standard labeling pattern.
- B. Provide jacks color coded as required.
- C. For faceplates where insert type labels are used, install clear plastic cover over preprinted or laser printed type label.
- D. For faceplates without insert type labels, use adhesive type labels. Affix labels to faceplate; marking faceplates is not permitted.
- E. Use adhesive type labels for all communications cable labels.
- F. Affix labels to cables; marking cable is not permitted.

- G. All Jack labels will be placed under clear plastic inserts. Labels are not to be placed on the surface of the faceplate unless an insert does not exist. In this instance, a single layer of clear tape is to be placed over the label. Further, a label is to be placed on the inside of the faceplate, also with a layer of clear tape over it.
- H. Jacks are labeled using the following format:
 - 1. <IDF Designation>
 - 2. <Rack Number><Patch Panel Designation>-<Port Number>
 - 3. E.g., If the faceplate contains jacks connected to ports 35 and 36 on Panel C (Rack2) in the Library Level 0 IDF (ID0) the label would be (single or dual jack)
 - a. LIBID0
 - b. 2C-35
 - c. 2C-36
 - 4. Faceplates with 3 or 4 jacks: LIBID0
 - a. 2C-35 2C-36
 - b. 2C-37 2C-38
 - 5. Faceplates with 5 or 6 jacks: LIBID0
 - a. 2C-35 2C-36
 - b. 2C-37 2C-38
 - c. 2C-39 2C-40

3.4 LABELING OF RISERS AND PATHWAYS

- A. Pathways shall be marked at each endpoint and at all intermediate pull or junction boxes. In the case of partitioned pathways (i.e., innerduct) each partition shall have a unique identifier.
- B. Riser cable, conduits and pull boxes shall be labeled at both ends.
- C. Use adhesive type labels.

3.5 LABELING OF EQUIPMENT RACKS, CABINETS, AND FRAMES

- A. On each equipment rack, distribution frame, and cabinet, provide a nameplate with white background and black lettering. The nameplate shall be minimum 1/2 inch high and have gothic style font. The nameplate shall be phenolic with engraved designation. Additionally, all rack mounted power strips and receptacles on racks, frames, or cabinets shall be labeled with panel name and circuit number.
- B. Starting at the top of rack 1 (defined in next paragraph) and moving down the rack each panel will be labeled sequentially starting with "A" (i.e., Rack 1 Panel A). Moving down Rack 1, the next panel will be "B", and so-forth. Moving to the rack to the right, the patch panel at the top of the second rack is Rack 2 Panel A and so forth. A label may be placed at the top of each rack designating the Rack number and a separate label placed on each patch panel designating the panel letter. Only copper panels (voice trunk and station cabling) are to be labeled with letters. LIU's will be labeled to identify location of far end of fiber.
- C. Rack 1 is the "left-most" rack when facing the front of the racks. Using the common left-to-right Western reading format, the "left-most" rack is the rack that is logically the starting point within the room.
- D. If the patch panel comes with factory numbering, it will not be altered/overlaid. If the patch panel does not come factory numbered, each patch panel will be numbered independent of others (i.e., the first port on each panel will start at "1").

END OF SECTION 27 05 53

SECTION 27 08 00 - TESTING OF COMMUNICATIONS CABLING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section describes the requirements for the testing of the technology system cabling plants including Category 6/6A cabling plant, UTP backbones, and optical fiber backbones.
- B. Section includes:
 - 1. Category 6/6A cable plant testing and documentation.
 - 2. Copper UTP backbone cabling plant testing and documentation.
 - 3. Optical fiber cable plant testing and documentation.
- C. Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed optical fiber cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber end faces shall also be verified.
- D. Testing shall be performed on each cabling link (connector to connector).
- E. All optical fiber tests shall be documented including OLTS dual wavelength attenuation measurements and OTDR traces with event tables as well as OTDR maps.
- F. Provide all labor, materials, tools, field-test instruments, and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.
- G. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- H. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.

1.3 DEFINITIONS

- A. OTDR: Optical Time Domain Reflectometer
- B. NEXT: Near End Cross-Talk

- C. ELFEXT: Equal Level Far End Cross Talk
- D. ACR: Attenuation to Cross-Talk Ratio
- E. UTP: Unshielded Twisted Pair

1.4 STANDARDS AND CODES

- A. ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
- B. ANSI/EIA/TIA 455 50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
- C. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR
- D. ANSI/TIA/EIA 455 60A, Measurement of Fiber or Cable Length Using an OTDR
- E. ANSI/TIA/EIA 455 61A, Measurement of Fiber or Cable Attenuation Using an OTDR
- F. ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
- G. ANSI/TIA-568-0.D, Generic Telecommunications Cabling for Customer Premises.
- H. ANSI/TIA-568-1.D, Commercial Building Telecommunications Cabling Standard
- I. ANSI/TIA 568 C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
- J. ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labeling requirements.
- K. ANSI/TIA-526-7-A (July 2015) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
- L. ANSI/TIA-598-D (July 2014) Optical Fiber Cable Color Coding

1.5 SUBMITTALS

- A. Product Data: For copper and optical fiber cabling testing equipment and documentation reports. Include the following information:
 - 1. Complete data sheet and specifications for all cable testing equipment to be used by the Contractor.
 - 2. List of cable types the equipment is designed to test.
 - 3. List of test standards equipment will test to.

4. List of testing parameters equipment will support.
 5. Letters from approved manufacturers of all components of the installed cabling plants to be tested and verified. The letter shall be an endorsement of the cable testing equipment for use with testing the specific products installed and approval for using cable testing equipment to verify performance and installation requirements for issuing product warranties. These letters shall be directly issued from the manufacturers on their letterhead to the approved cable testing equipment manufacturer.
- B. Sample Test Reports: Provide a sample test report sheet for each type of cable test required to be performed. The sample test reports shall indicate the format and all test parameters that are required to be provided.
- C. Equipment Calibration Certificates: Provide certificate indicating date and procedures used to calibrate all test equipment used. Provide verification that equipment has been calibrated according to manufacturer's recommendations.
- D. Testing Procedures: Provide a description of cable testing procedures to be used for each type of cable test required. List applicable standards and methodologies to be implemented in the testing processes.
- E. Pre-installation Test Reports: Submit pre-installation test reports of optical fiber on the reel performed at the project site prior to installation. In addition, submit manufacturer's factory test documentation for comparison.

1.6 QUALITY ASSURANCE

- A. Source Limitations: All cable tests of same type shall be performed by identical cable test equipment from the same manufacturer.
- B. Application Assurance Warranties: The entire cabling plant shall be warranted as required by the approved manufacturers. The specified warranties shall require full repair or replacement of defective material and labor that does not perform to project specifications.
- C. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
1. Manufacturer of the connectors or cable.
 2. Manufacturer of the test equipment used for the field certification.
 3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)

1.7 COORDINATION

- A. Notify the Owner, Architect, and Construction Manager (if used for the project) a minimum of seven days prior to performing cable testing and provide a

schedule indicating cables and locations that will be tested. The Owner or Architect may observe testing at their discretion.

1.8 GENERAL

- A. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions.
- B. All copper pairs or optical fibers of each installed cable shall be tested and verified prior to system acceptance.
- C. Any defect in the cabling system performance or installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors or fibers in all cables installed.
- D. All cables shall be tested in accordance with this document, the ANSI/TIA Standards, System Warranty guidelines and best industry practice.
- E. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

1.9 CATEGORY 6/6A ACCEPTANCE OF TEST RESULTS

- A. Category 6/6A Cabling Plant: Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in tested for:
 - 1. Wire Map
 - 2. Length
 - 3. Propagation Delay
 - 4. Delay Skew
 - 5. DC Loop Resistance
 - 6. DC Resistance Unbalance within a pair
 - 7. DC Resistance Unbalance between pairs
 - 8. Insertion Loss
 - 9. NEXT (Near-End Crosstalk)
 - 10. PS NEXT (Power Sum Near-End Crosstalk)
 - 11. ACR-N (Attenuation to Crosstalk Ratio Near-End)
 - 12. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 - 13. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - 14. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - 15. Return Loss
 - 16. TCL (Transverse Conversion Loss)
 - 17. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - 18. PS ANEXT (Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
 - 19. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
 - 20. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2

21. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2

- B. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described in Part 3. Any Permanent Link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation in accordance with Part 3.
- C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

1.10 Performance Test Parameters –Fiber Optic Cable

- A. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall in compliance with the following test limits.

1. Optical Loss Testing, Multimode and Singlemode Links:

- a. ANSI/TIA/EIA standards prescribe that the single performance parameter for field testing of fiber optic links is link attenuation (alternative and equivalent term: insertion loss), when installing components compliant with this standard.
- b. The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA:
 - 1) $\text{Link Attenuation} = \text{Cable_Attn} + \text{Connector_Attn} + \text{Splice_Attn}$
 - 2) $\text{Cable_Attn (dB)} = \text{Attenuation_Coefficient (dB/km)} * \text{Length (Km)}$
 - 3) The values for the Attenuation_Coefficient are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation_Coefficient (dB/km)	Wavelength (nm)	Attenuation_Coefficient (dB/km)
Single-mode (Outside plant)	1310	0.5	1550	0.5
Single-mode (Inside Plant)	1310	1.0	1550	1.0
Multimode 62.5/125 micrometer	850	3.5	1300	1.5
Multimode 50/125 micrometer	850	3.5	1300	1.5

- 4) $\text{Connector_Attn (dB)} = \text{number_of_connector_pairs} * \text{connector_loss (dB)}$
- 5) Maximum allowable connector_loss = 0.75 dB
- 6) $\text{Splice_Attn (dB)} = \text{Number of splices} * \text{splice_loss (dB)}$.
- 7) Maximum allowable splice_loss = 0.3 dB.

- c. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- d. Test equipment that measures the link length and automatically calculates the link loss based on the above formulas is required.
- e. The previous link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.
- f. Single mode backbone links shall be tested in both directions at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA, One Reference Jumper. All single mode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm. Links destined to be used with network applications that use laser light sources (underfilled launch conditions shall be tested with test equipment based on laser light sources. This rule shall be followed for Technology systems to support Gigabit Ethernet.

2. OTDR Testing

- a. Reflective events (connections) shall not exceed:
 - 1) 0.75 dB in optical loss when bi-directionally averaged
 - 2) -35 dB Reflectance for multimode connections
 - 3) -40 dB reflectance for UPC singlemode connections
 - 4) -55 dB reflectance for APC singlemode connections
- b. Non-reflective events (splices) shall not exceed 0.3 dB.

3. Magnified end face inspection

- a. Fiber connections shall be visually inspected to IEC 61300-3-35 Edition 1.0 for end face quality.
 - b. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
- B. All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in Part 3. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with Part 3.
- C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

D. Performance specification for multimode fiber links at 850 nm:

Fiber Type		Bandwidth	1000BASE-SX		10GBASE-SR		FibreChannel 1200-MX-SN-I	
	μm	(MHz• Km)	Length (m)	Loss (dB)	Length (m)	Loss (dB)	Length (m)	Loss (dB)
OM1	62.5	200	275	2.38	33	2.5	33	2.4
OM2	50	500	550	3.56	82	2.3	82	2.2
OM3	50	2000	N/A	N/A	300	2.6	300	2.6
OM4	50	47000	N/A	N/A	400	2.9	N/A	N/A

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Category 6/6A and Copper Backbone Test Equipment

1. Manufacturers: Subject to compliance with requirements, provide required cable testing and documentation with cable testing equipment by one of the following:
 - a. Agilent Technologies
 - b. Fluke Networks
 - c. JDSU LANTEK
2. The field-test instrument shall be within a 12 month calibration period.
3. Certification tester
 - a. Accuracy
 - 1) Level IIIe accuracy in accordance with ANSI/TIA-1152
 - 2) Independent verification of accuracy shall be provided
4. Permanent Link Adapters
 - a. RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
 - b. Twisted pair Category 5e, 6, 6A, 7 or 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures
5. Results Storage
 - a. Must be capable of storing > 10,000 results for all measurements found in 2.1.B.4 below
6. Measurement capabilities
 - a. Wire Map
 - b. Length
 - c. Propagation Delay
 - d. Delay Skew
 - e. DC Loop Resistance

- f. DC Resistance Unbalance within a pair
- g. DC Resistance Unbalance between pairs
- h. Insertion Loss
- i. NEXT (Near-End Crosstalk)
- j. PS NEXT (Power Sum Near-End Crosstalk)
- k. ACR-N (Attenuation to Crosstalk Ratio Near-End)
- l. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
- m. ACR-F (Attenuation to Crosstalk Ratio Far-End)
- n. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
- o. Return Loss
- p. TCL (Transverse Conversion Loss)
- q. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
- r. Time Domain Reflectometer
- s. Time Domain Xtalk Analyzer
- t. PS ANEXT (Power Sum Alien Near-End Crosstalk)
- u. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
- v. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
- w. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

7. PC Software

B. Optical Fiber Cable Testers

1. Optical Fiber Test Equipment

- a. Manufacturers: Subject to compliance with requirements, provide required cable testing and documentation with cable testing equipment by one of the following:

- 1) Agilent Technologies
- 2) Fluke Networks
- 3) JDSU LANTEK

- 2. The field-test instrument shall be within the calibration period recommended by the manufacturer and a copy of the calibration certificate made available.

3. Optical loss test set (OLTS)

- a. Multimode optical fiber light source

- 1) Provide dual LED light sources with central wavelengths of 850 nm (+/-30 nm) and 1300 nm (+/-20 nm). VCSEL sources are not permitted per ANSI/TIA-526-14-B.
- 2) Output power of -20 dBm minimum.
- 3) The launch shall meet the Encircled Flux launch requirements of ANSI/TIA 526-14-B.
- 4) The test reference cords must demonstrate an insertion loss \leq 0.15 dB when mated against each other.

- b. Singlemode optical fiber light source
 - 1) Provide dual laser light sources with central wavelengths of 1310 nm (+/-20 nm) and 1550 nm (+/-20 nm).
 - 2) Output power of -10 dBm minimum.
 - 3) The test reference cords must demonstrate an insertion loss \leq 0.25 dB when mated against each other.
- 4. Power Meter
 - a. Provide 850 nm, 1300 nm, 1310 nm, and 1550 nm wavelength test capability.
 - b. Power measurement uncertainty of +/- 0.25 dB.
 - c. Store reference power measurements.
 - d. Save at least 10,000 results to internal memory.
 - e. PC interface (USB).
- 5. Length measurement
 - a. It is preferable to use an OLTS that is capable of measuring the optical length of the fiber using time-of-flight techniques. In the case of MPO/MTP trunk cables, this is not possible.
- 6. Optical Time Domain Reflectometer (OTDR)
 - a. Shall have a bright, color LCD display with backlight.
 - 1) Shall have rechargeable Li-Ion battery for 8 hours of normal operation.
 - b. Weight with battery and module of not more than 4.5 lb and volume of not more 200 in³.
 - c. Internal non-volatile memory with capacity for storing at least 2,000 OTDR bi-directionally tested fiber links.
 - d. USB port to transfer data to a PC or thumb drive/memory stick.
- 7. Multimode OTDR
 - a. Wavelengths of 850 nm (\pm 10 nm) and 1300 nm (+ 35 nm / - 15 nm).
 - b. Event dead zones not to exceed 0.7 m at 850 nm and 1300 nm.
 - c. Attenuation dead zones not to exceed 2.5 m at 850 nm and 4.5 m at 1300 nm.
 - d. Distance range not less than 9,000 m.
 - e. Dynamic range at least 28 dB for 850 nm and 30 dB at 1300 nm.
 - f. Allow bi-directional testing without moving the OTDR to the far end.
- 8. Singlemode OTDR
 - a. Wavelengths of 1310 nm (+/- 25 nm) and 1550 nm (+/- 30 nm).
 - b. Event dead zones not to exceed 0.6 m at 1310 nm and 1550 nm.
 - c. Attenuation dead zones not to exceed 3.7 m at 1310 nm and 1550 nm.

- d. Distance range not less than 80 km at 1310 nm and 130 km at 1550 nm.
- e. Dynamic range at least 32 dB for 1310 nm and 30 dB at 1550 nm.
- f. Allow bi-directional testing without moving the OTDR to the far end.

9. Fiber Microscope

- a. Field of view 420 μm x 320 μm
 - 1) Video camera systems are preferred.
 - 2) Camera probe tips that permit inspection through adapters are required.
 - 3) Test equipment shall be capable of saving and reporting the end face image to IEC 613003-3-35.

10. Integrated OLTS, OTDR and fiber microscope

- a. Test equipment that combines into one instrument an OLTS, an OTDR and a fiber microscope may be used.

PART 3 - EXECUTION

3.1 GENERAL

- A. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- B. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

3.2 FIELD QUALITY CONTROL

- A. Category 6/6A Installation: Field test requirements upon completion of the installation.
- B. Field-test instruments shall have the latest firmware installed.
- C. Permanent Link test results, including the individual frequency measurements from the tester, shall be recorded in the test instrument upon completion of each test for subsequent uploading to PC in which the administrative documentation (reports) may be generated.
- D. Permanent Link testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.

- E. Alien Crosstalk testing shall be performed using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859-1 for populations of up to 500,000 links shall be used. The following table represents this sampling level.

Total number of links (N)	Sample size (No. of links to test)
3 – 33	3 or 0.1 x N (whichever is greatest)
34 – 3,200	33
3,201 – 35,000	126
35,001 – 150,000	201
150,001 – 500,000	315

- F. Disturbed (Victim) links chosen for Alien Crosstalk testing shall be an equal combination of short, medium and long links.
- G. Permanent Link adapters made from twisted pair Category 5e, 6, 6A, 7 or 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- H. The installer shall build a reference link. All components shall be anchored so it is not possible to disturb them. The technician is to conduct a Category 6A Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.

3.3 INTRABUILDING COPPER BACKBONE VOICE RISER TESTING

- A. Copper cable backbone shall be tested for the following. Each wire/pair shall be tested at both ends for the following utilizing Contractor's standard form.
1. Termination order
 2. Polarity
 3. Continuity
 4. Shorts
 5. Grounds
 6. Cable length, record all length.

3.4 COPPER LINK TESTING

- A. All twisted-pair copper cable links shall be tested for compliance to the requirements in ANSI/TIA 1152 and ANSI/TIA 568-C.2 for the appropriate Category of cabling installed using a test unit meeting a minimum IEC IIIe level of accuracy.
- B. All testers used must have been factory calibrated by the manufacturer within one year of use or according to factory calibration recommendations, whichever is the more stringent.

- C. Contractor shall set references according to manufacturer's recommendation prior to each day's testing and reset references anytime tester is left unused for more than two hours.
- D. For warranty purposes, Contractor shall perform the appropriate Permanent Link test. Channel Link testing is rendered void by the movement of patch cords and can be run but not used for final acceptance criteria.

3.5 OPTICAL FIBER CABLE TESTING

- A. Field-test instruments shall have the latest software and firmware installed.
- B. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- C. Fiber end faces shall be inspected using a video scope with a field of view not less than 425 μm x 320 μm .
 - 1. It is preferable that the end face images be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.
- D. Testing shall be performed on each cabling segment (connector to connector).
- E. Testing of the cabling shall be performed using high-quality test reference cords of the same core size as the cabling under test, terminated with reference grade connectors. Reference grade connectors are defined as having a loss not exceeding 0.1 dB for multimode and 0.2 dB for singlemode. The test reference cords for OLTS testing shall be between 2 m and 5 m in length. The length of the launch and tail fibers for multimode OTDR testing shall be at least 100 m (328 ft.). For singlemode, the length of the launch and tail fibers will depend on the link under test. As a guide, the following table can be used for determining the length of the launch and tail fibers.

Maximum Length of Link (km)		Typical Pulse Width (ns)	Minimum Launch and Tail Cord Length (m)
1310 nm	1550 nm only		
0 to 35	0 to 50	$\leq 1,000$	130
35 to 45	50 to 65	3,000	400
45 to 50	65 to 75	10,000	1,000
≥ 50	≥ 75	20,000	2400

- F. Terminated fiber strands shall be tested for attenuation with an optical power meter and light source and OTDR. All OTDR records shall be delivered to the engineer at the conclusion of the project, appropriately labeled by cable, strand and termination location.
- G. Every fiber optic technology link in the installation shall be bi-directionally tested in accordance with the field test specifications defined in the most recent standard of the Telecommunications Industry Association (TIA)/Electronics Industry Association (EIA).

- H. Test cables upon receipt at project site. Test optical fiber cables to determine the continuity of the strand end to end. Use optical loss test set. Test optical fiber cables while on reels.
- I. ANSI/TIA/EIA Standards, define the passive network, to include cable, and connectors, between two optical fiber patch panels (connecting hardware). A typical horizontal link segment is from the telecommunications outlet/connector to the horizontal cross-connect. The standards describe three typical backbone link segments: (1) main cross-connect to intermediate cross-connect, (2) main cross-connect to horizontal cross-connect, or (3) intermediate cross-connect to horizontal cross-connect.
- J. The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test shall not, however, include the performance of the connector at the interface with the test equipment.
- K. 100% of the installed links shall be tested and shall pass the requirements of the TIA/EIA standards. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation.
- L. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - 1. The manufacturer of the fiber optic cable and/or the fiber optic connectors
 - 2. The manufacturer of the test equipment used for the field certification
 - 3. Training organizations authorized by BICSI (Building Industry Consulting Services International with headquarters in Tampa, Florida) or by the ACP (Association of Technology Professionals™) Technology Business Institute located in Dallas, Texas.
- M. Field test instruments for single mode fiber Technology shall meet the requirements of ANSI/EIA/TIA.
- N. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
- O. The fiber optic launch cables and adapters shall be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.
- P. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests specified herein.
- Q. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.
- R. The Owner shall be notified of the start date of the testing phase 5 business days before testing commences.

S. Pre-installation tests of inter-plant fiber-pre-test each reel:

1. Test each strand of each reel of fiber for continuity with an OTDR. If continuity is not achieved test to determine the nature and location of the defect: Measure end-to-end attenuation and the distance to a high attenuation point.
2. If it is determined that the fiber is defective, contact the manufacturer and provide a completely new fiber reel.

T. Optical loss testing

1. Horizontal/Backbone link
 - a. Multimode links shall be tested in one direction at 850 nm and 1300 nm in accordance with ANSI/TIA-526-14-B, one-cord reference method, with an Encircled Flux compliant launch.
 - b. Singlemode backbone links shall be tested in one direction at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1 (One-cord reference method).
 - c. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

U. OTDR Testing

1. Fiber links shall be tested at these wavelengths for anomalies and to ensure uniformity of cable attenuation, connector insertion loss and reflectance.
 - a. Multimode: 850 nm and 1300 nm.
 - b. Singlemode: 1310 nm and 1550 nm.
2. Each fiber link and channel shall be tested in both directions.
 - a. The launch and tail fibers shall remain in place for the measurement in the opposite direction – failing to do so will result in an increase in measurement uncertainty.
 - b. The use of a loop back fiber at the far end with a tail fiber at the near end on the adjacent fiber is permitted for bi-directional testing, so long as the OTDR is able to split the trace automatically into two traces for the two fibers under test.
3. A launch cable shall be installed between the OTDR and the first link connection.
4. A tail cable shall be installed after the last link connection.

V. Magnified End Face Inspection

1. Fibers shall be inspected using a video scope with a minimum field of view 425 μm x 320 μm to IEC 61300-3-35 Edition 1.0. The following test limits shall be used:
2. Singlemode field polished connectors; Table 5 of IEC 61300-3-35 Edition 1.0
3. Singlemode factory polished connectors; Table 3 of IEC 61300-3-35 Edition 1.0

W. Length Measurement

1. The length of each fiber shall be recorded.
2. It is preferable that the optical length be measured using an OLTS or OTDR.

X. Polarity Testing

1. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA 568 C.0. The polarity of the paired duplex fibers shall be verified using an OLTS.

3.6 TEST RESULT DOCUMENTATION

- A. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Owner for approval. Documentation shall include the items detailed in the sub-sections below.
- B. Documentation shall be submitted within ten (10) working days of the completion of each testing phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.
- C. At the request of the Owner, the telecommunications contractor shall provide copies of the original test results in tester native format, not spreadsheet.
- D. The Owner may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by Information Technologies, including a 100% re-test. This re-test shall be at no additional cost to the Owner.
- E. Documentation shall be provided in electronic format within three weeks after the completion of the project. The media shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year).
- F. The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). Documentation shall also include test equipment name, manufacturer, model number, serial number, software version and last factory calibration date.
- G. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation.
- H. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

- I. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. Alternately, the telecommunications contractor may furnish this information in electronic form.
- J. The media shall contain the electronic equivalent of the test results as defined by the specification along with the software necessary to view and evaluate the test reports.
- K. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.
- L. The As-Built drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations.
- M. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.
- N. These documents will be modified accordingly by the Contractor to denote as-built information as defined above and returned to the Owner.
- O. The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (AutoCAD) form.
- P. The test results information for each link shall be recorded in the memory of the field tester upon completion of the test.
- Q. The test results recorded saved by the tester shall be transferred into a Windows-based database utility that allows for the maintenance, inspection and archiving of these test records. The measurement results must be transferred to the PC unaltered, i.e. "as saved in the tester" at the end of each test and that these results cannot be modified at a later time.
- 1. General information to be provided in the electronic data base with the test results information for each link:
 - a. The identification of the Owner site as specified by the end-user.
 - b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - c. The overall Pass/Fail evaluation of the link-under-test.
 - d. The name of the standard selected to execute the stored test results.
 - e. The cable type and the value of NVP used for length calculations.
 - f. The date and time the test results were saved in the memory of the tester.
 - g. The brand name, model and serial number of the tester.
 - h. The identification of the tester interface.
 - i. The revision of the tester software and the revision of the test standards database in the tester.
 - j. The test results information must contain information on each of the required test parameters that are listed in this Section.

2. The detailed test results data to be provided in the electronic database for each tested link must contain the following information:
 - a. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. In this case, the PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
 - 1) Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1) and the test limit value.
 - 2) Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
 - 3) Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value.
 - 4) Attenuation: Minimum test results documentation for the worst pair.
 - 5) Return Loss: Minimum test results documentation for the worst pair as measured from each end of the link.
 - 6) NEXT, ELFEXT, ACR: Minimum test results documentation for the worst pair combination as measured from each end of the link.
 - 7) PSNEXT, PSELFEXT, and PSACR: Minimum test results documentation for the worst pair as measured from each end of the link.

END OF SECTION 27 08 00

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Telecommunications mounting elements.
 - 2. Backboards.
 - 3. Telecommunications equipment racks.
 - 4. Grounding.
- B. Related Requirements:
 - 1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
 - 2. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.
- C. The intent of this section is to furnish of all necessary labor, supervision, materials, and equipment to fit out all Telecommunication rooms/spaces as shown on the drawings.
- D. Provide cable supports, pull boxes, tube supports, fiber distribution units and accessories in telecommunication room/spaces (as indicated on drawings).
- E. Provide plywood backboards as required to support newly installed equipment. Anchors for plywood will be sufficient to support equipment apparatus, with attaching hardware flush or not protruding out from the plywood surface.
- F. Provide equipment racks, grounding and all necessary hardware in the room to support the low voltage systems.
- G. Contractor shall modify rooms and rack equipment to install new equipment with approval from the Owner or Owners Representative prior to installation.
- H. Communication grounding and bonding shall be in accordance with applicable codes and regulations. The requirements of TIA-607E shall be observed throughout the entire cabling system.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. RCDD: Registered communications distribution designer.
- D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E. PBB: Primary Bonding Busbar
- F. SBB: Secondary Bonding Busbar

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
- C. Submit all data and drawings in one complete package for review.
- D. Partial submittals will not be reviewed; it is the Contractor's responsibility to submit complete information. Submitted information shall be initialed or signed by the contractor, showing the date and the contractor's legitimate firm name.
- E. The Owner or Owners Representative's review and approval, or other appropriate action upon shop drawings, product data, and samples, is for the limited purpose of checking for conformance with information given and design concept expressed in the contract documents. The Owner or Owners Representative's review of such submittals is not conducted for the purpose of determining accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the contractor as required by the contract documents.

- F. The Owner or Owners Representative will not check incomplete or illegible submittals. The Owner or Owners Representative will only review one re-submittal. All additional reviews will be charged back to the contractor on an hourly basis plus any expenses and deducted from the contract amount.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Seismic Qualification Data: Certificates, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of Technician and RCDD.
 - 2. Installation Supervision: Installation shall be under direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

1.7 RECORD DOCUMENTS

- A. When all work has been completed and prior to final acceptance, the Contractor shall furnish to the Owner or Owners Representative a complete set of reproducible contract marked drawings clearly showing all contract work "as-built". Prior to delivery each drawing shall be signed and dated by the Contractor's project manager attesting to the accuracy.
- B. Contractor will document daily the as-built conditions and any pertinent as-built information. The Owner Project Manager and/or Owner or Owners Representative can request to view these documents upon any visit. If documents are not current the Contractor will rectify the condition and submit accurate documents the following work day.

- C. Mark up a clean set of Specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- D. As-Built Drawings.
 - 1. In addition to the requirements of Division 1, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations. All drawings shall be redlined on two sets.

PART 2 - PRODUCTS

2.1 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 in thick
- B. Paint plywood backboards. Do not paint over fire rated labels which must be legible on every piece of installed plywood.
- C. Provide wire distribution rings and spools as required for a neat and workman like installation. All of these devices shall be made of high-impact plastic and used to neatly guide and retain wall mounted cable or jumper wires. Spools and rings shall be properly sized to accommodate installed cabling and 50% growth.

2.2 EQUIPMENT RACKS

- A. Manufacturers: Subject to compliance with the specifications products shall be as manufactured by the following:
 - 1. Panduit 2-Post Standard Equipment Rack 84" H x 23" W #12-24 Threaded rail (R2PW)
 - 2. Panduit NetManager HC 2RU horizontal cable manager (NMF2).
 - 3. Panduit NetRunner Dual Sided 6.7in vertical cable manager (WMPVHC45E) or Panduit NetRunner Dual Sided 4.9 (WMPV45E) if space is limited.
 - 4. Panduit vertical CM part# PVR6
 - 5. Panduit SmartZone™ Monitored Switched PDU part# P18E23M Panduit horizontal CM part# WMPF1E
 - 6. Panduit SmartZone Monitored Switched PDU 30A, 120V PDU, MOUNTED VERTICALLY, (18) 5-20R RECEPTACLES,

2.3 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Rack and Cabinet RBB's: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-e. Predrilling shall be with holes for use with lugs specified in this Section.

2.4 LABELING

- A. Comply with TIA-606-D and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:

1. Install from 6 inches to 8 feet, 6 inches above finished floor UON. Ensure that fire-rating stamp is visible after installation.
2. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

H. Assemble racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment.

I. Racks shall be grounded to the bonding busbar using appropriate hardware provided by the contractor.

J. Ladder rack may be attached to the top of the rack to deliver cables to the rack. The rack shall not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.

K. The equipment load will be evenly distributed and uniform on the rack. Place large and heavy equipment towards the bottom of the rack. Secure all equipment to the rack with equipment mounting screws. In seismic areas, secure equipment to shelves with additional bracing.

L. Accessory Equipment Mounting Rails: Equipment must be attached to the equipment mounting rails and must not exceed the accessory equipment mounting rails load capacity. Verify that the rack has sufficient load capacity for the accessory equipment mounting rails and equipment.

3.3 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Bond the shield of shielded cable to patch panel, and bond patch panel to SBB or PBB.

3.4 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Communications Systems."

B. Paint and label colors for equipment identification shall comply with TIA-606-B.

C. Labels shall be machine printed. Type shall be 1/4 inch in height.

3.5 FIRESTOPPING

A. Comply with requirements in Section 078400 "Firestopping."

- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 27 11 00

SECTION 27 11 23 - COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

- A. Section 078400 – Firestopping.
- B. Section 270526 - Grounding and Bonding for Communications Systems.
- C. Section 270529 - Hangers and Supports for Communications Systems.

1.3 DESCRIPTION

- A. This specification section describes the type of cable runway to be used above racks and on walls in the Telecom Room(s).
- B. Work covered in this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the cable runway system as described in this specification and as shown on the drawings.
- C. Work included in this section: Materials, equipment, fabrication, installation and tests in conformity with applicable codes and authorities having jurisdiction (AHJ) for the following:
 - 1. Cable runway
 - 2. Cable runway support systems.
 - 3. Cable runway accessories.
- D. Coordinate installation and final placement above racks with Owner.
- E. Provide necessary fittings, supports, and other hardware, which may be required to provide a complete installation. The complete systems shall be assembled from factory supplied parts.
- F. Coordinate the exact location of all cable trays with all other trades in order to avoid space conflicts or to avoid interference with the designed flow of air.

1.4 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International
- B. EIA: Electronic Industries Alliance.
- C. TIA: Telecommunications Industry Association

- D. ANSI: American National Standard Institute

1.5 REFERENCES

- A. ANSI/TIA-569-E Telecommunications Pathways and Spaces, 2015
- B. ANSI/TIA-568-E.0 Generic Telecommunications Cabling for Customer Premises, 2015
- C. ANSI/TIA-568-E.1 Commercial Building Telecommunications Cabling Standard, 2015.
- D. ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure, 2012.
- E. ANSI/TIA-607-E Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, 2015.
- F. BICSI – Telecommunications Distribution Methods Manual, Latest Edition
- G. NFPA 70 – National Electric Code, 2014.
- H. ASTM International:
1. ASTM-Specification for Carbon Structural Steel.
 2. ASTM A1011- Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A570).
 3. ASTM 513 – Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing.
 4. ASTM B633- Specification for Electro-Deposited Coatings of Zinc on Iron and Steel.
 5. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 6. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. National Electrical Manufacturers Association:
1. NEMA FG 1 - Nonmetallic Cable Tray Systems.
 2. NEMA VE 1 - Metal Cable Tray Systems.
 3. NEMA VE 2 - Metal Cable Tray Installation Guidelines.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for cable management and ladder racks.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Include fittings and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate bonding requirements and location of bonding bus bar.

1.7 QUALITY ASSURANCE

- A. Zinc plated cable runway shall be classified by Underwriters Laboratories (UL).
- B. Cable runway shall be of uniform quality and appearance.
- C. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the owner or owner representative.
- D. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
- E. Supply all equipment and accessories new and free from defects.
- F. Supply all equipment and accessories in compliance with the applicable standards listed in Article 1.2 of this Section and with all applicable national, state and local codes.
- G. All items of a given type shall be the products of the same manufacturer.
- H. NEC Compliance: Comply with NEC, as applicable to construction and installation of cable runway and cable tray systems (Article 318, NEC).
- I. NFPA compliance Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance" pertaining to installation of cable tray systems.
- J. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association

(TIA) recommended installation practices when installing communications/data cabling.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver cable runway systems and components carefully to avoid breakage, bending and scoring finishes. Do not install damaged equipment.
- B. Store cable runways and accessories in original cartons and in clean dry space; protect from weather and construction traffic.

PART 2 - PRODUCTS

2.1 TELECOMMUNICATIONS ROOM CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Chatsworth Products (CPI)
 - 2. Cooper B-Line
 - 3. Hubbell
 - 4. Legrand
 - 5. Panduit
- B. Size: 1.5 inches high by 0.4 inches wide high tubular steel with 0.065 inch wall thickness.
- C. Stringers: 9 feet 11-1/2 inches long.
- D. Cross Members: Welded in between stringers on 12 inch intervals/centers beginning 5-3/4 inches with 10 cross members per ladder rack. Open space of 10-1/2 inches between each cross member.
- E. Finish and Color: Powder coat paint in black.
- F. Provide width as shown on the drawings.
- G. Supports shall be positioned as recommended by manufacturer and anchored to the building structure.
- H. Cable runway shall be steel and meet ASTM A570.
- I. Cable runway shall be finished black.
- J. Bond each cable runway joint with a UL listed grounding device and ground tray according to manufacturer's recommendations to maintain UL and NEC grounding requirements and listings.
- K. Cable runway shall have UL listing.

2.2 LADDER RACK ACCESSORIES

- A. Horizontal 90° Turns (Cable Runway E-Bend): 1-1/2 inches by 3/8 inch wide tubular steel with 0.065 inch wall thickness.
- B. Vertical-To-Horizontal 90° Turns (Cable Runway Outside Radius Bend): 1-1/2 inches by 3/8 inch wide tubular steel with 0.065 inch wall thickness.
- C. Horizontal-To-Vertical 90° Turns (Cable Runway Inside Radius Bend): 1-1/2 inches by 3/8 inch wide tubular steel with 0.065 inch wall thickness.
- D. Corner Brackets (Cable Runway Corner Bracket): 1-1/2 inches by 3/8 inch wide tubular steel with 0.065 inch wall thickness.
- E. Ladder Rack Splices: Mechanically connects ladder rack sections and turns together end-to-end or side-to-end to form a continuous pathway for cables.
 - 1. Butt-Splice Kit.
 - 2. Junction-Splice Kit.
 - 3. Heavy-Duty Butt-Splice Kit.
 - 4. Heavy-Duty Junction-Splice Kit.
 - 5. Adjustable Junction-Splice Kit.
 - 6. Runway-Splice Kit.
 - 7. Butt Swivel Splice Kit.
 - 8. Junction Swivel Splice Kit.
 - 9. Vertical Swivel Splice Kit.
 - 10. Grounding Kit.
 - 11. Ladder Rack Supports: Sized to match the width of the ladder rack that is supported.
 - 12. Triangular Support Bracket.
 - 13. Wall Angle Support Kit.
 - 14. Foot Kit.
 - 15. Adjustable Floor Support Channel.
 - 16. Threaded Ceiling Kit.
 - 17. Center Support Kit.
 - 18. Rack-to-Runway Mounting Plate.
 - 19. Cable Runway Elevation Kit.
 - 20. Vertical Wall Brackets.
- F. Miscellaneous Accessories:
 - 1. Tool-less Pathway Dividers: 6.8 inches high by 1.5 inches wide by 2.2 inches deep Polycarbonate/Acrylonitrile Butadiene Styrene (PC/ABS) thermoplastic material.
 - 2. Tool-less Cross Member Radius Drops: 0.060 inch thick Steel and measure 4.6 inches high by 6.1 inches.
 - 3. Tool-less Stringer Radius Drops: 0.060 inch thick steel and measure 4.6 inches high by 4.6 inches deep.
 - 4. Saf-T-Grip Reusable Cable Management Straps: Open loop series.
 - 5. Cable Retaining Post.

6. Cable Runway Protective End Caps.
7. Touch-Up Paint: Spray Can in black.
8. Miscellaneous Hardware: Includes cable runway support brackets, ceiling support brackets, cable runway slotted support brackets, slip-on cable runway support brackets, slip-on lock nuts, hex nuts, split lock washers, washers, hex lag screws, and anchors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.
- B. Install metal cable tray in accordance with NEMA VE 2.
- C. Install firestopping in accordance with project documents to sustain ratings when passing cable tray through fire-rated elements.
- D. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- E. Install with side stringers facing down so the runway forms an inverted U-shape and that the hardware between the stringers and cross members face away from cables.
- F. Secure to the structural ceiling, building truss system, wall, floor or tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate hardware, as defined by local code or the authority having jurisdiction (AHJ).
- G. Support requirements:
 1. Ladder Rack (cable runway): 5 feet or less in accordance with TIA-569-B.
 2. Splices: Within 2 feet
 3. Intersections: Within 2 feet on all sides of every intersection.
 4. Changes in Elevation: Within 2 feet on both sides.
 5. Attached vertically to wall: 2 feet.
 6. Secure to each support with included hardware with a minimum of two fasteners.
 7. Splices: Place mid-span, not over a support, with the manufacturer's recommended splice hardware.
 8. Overhead installation clearances:
 - a. Above ladder rack: 12 inches minimum.
 - b. From building or ceiling structure: 12 inches minimum.
 9. Between ladder rack and the tops of equipment racks and/or cabinets: 3 inches.
 10. Multiple ladder rack tiers: 12 inches minimum.
 11. Runway crossovers: 3 inches.

H. Grounding Requirements

1. Within each telecommunications room, bond ladder rack together, electrically continuous, and bonded to the telecommunications bonding busbar, unless otherwise noted.
2. Bond ladder rack and turns across each splice with a UL Classified Splice Kit or other accepted method as recommended by the AHJ. Bond cable runway to the bonding busbar using an approved ground lug with a wire sized per local code, ANSI/TIA-607-C, or as recommended by the AHJ. Verify the bonds at splices and intersections between individual ladder rack sections and turns, as well as the bonding busbar.

I. Cable fill tolerances:

1. Maximum: 6 inches high.
2. Over 2 inches or non-secured cables: Install 8 inch high cable retaining posts or 6 inch high pathway dividers.
3. Quantity of cables: Not to exceed a whole number value equal to 50 percent of the interior area of the ladder rack, divided by the cross-sectional area of the cable. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2 inches, unless cable retaining posts/pathway dividers are added to the runway. The interior area of ladder rack equipped with cable retaining posts/pathway dividers will be considered to be the width of the ladder rack multiplied by a height of 6 inch. Actual cable fill for ladder rack that is not equipped with cable retaining posts/pathway dividers will not exceed 2 inches in height. Actual cable fill for ladder rack equipped with cable retaining posts/pathway dividers will not exceed 6 inch in height.

J. Weight of cables: Not to exceed the stated load capacity of the ladder rack as stated in the manufacturer's product specifications or design tables.

K. Secure cables (cable bundles) to the cross members with 3/4 inch wide reusable straps.

L. Cover the exposed ends of the ladder rack that do not terminate against a wall, the floor or the ceiling with fire-retardant black colored end caps made from a rubberized material or an end closing kit consisting of a flat bar of ladder rack stringer material factory cut to the width of the ladder rack and secured to the ladder rack with a junction splice kit.

M. Separate different cable media types within the ladder rack using pathway dividers. Treat each type of cable media separately when determining cable fill limits.

N. Where cable exits or enters the end, middle or side of overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field, a radius drop shall be used to guide the cable.

O. Maintain a minimum separation of 2 feet between ladder rack used for communications cables and pathways for other utilities or building services.

- P. Touch-up paint color-matched to the finish on the component and will correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the owner. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, the component will be replaced with a new component finished from the factory. If a component is physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the ladder rack system.
- Q. Install cable runways using hardware, splice connectors, support components, joint ground bonding, and accessories available from the manufacturer. Provide all accessories for complete installation that is approved by the Engineer.
- R. Cable tray shall be installed on walls, racks, and supported frame structure as required.
- S. Cable tray shall be installed below the finished ceiling and above the equipment racks.

END OF SECTION 27 11 23

SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. High-count Category 3 twisted pair cable for intrabuilding and interbuilding backbones.
 - 2. Grounding provisions for twisted pair cable.
 - 3. Cabling identification.
 - 4. Source quality control requirements for twisted pair cable.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. F/FTP: Overall foil screened cable with foil screened twisted pair.
- D. FTP: Shielded twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- H. LAN: Local area network.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.

- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. S/FTP: Overall braid screened cable with foil screened twisted pair.
- M. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER BACKBONE CABLING DESCRIPTION

- A. Copper backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Copper backbones rated for intrabuilding and interbuilding outside plant applications shall be required.
- C. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.
- D. Data Center copper will be terminated on Green Hamaco 66-block wall boards in the Data Center and 110/RJ-45 panels in the remote Building MDF. If the telecom switch needs to be expanded, Purple Hamaco 66- block wall boards will be installed with telco cables run between board and Telephone Switch.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration Drawings and printouts.
 - 4. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system

- e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
- 5. Cross-Connects and Patch Panels: Detail mounting assemblies, and show elevations and physical relationship between the installed components.
- C. Twisted pair cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Product Certificates: For each type of product.
- D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings a Technician.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as a Technician to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.12 BACKBONE CROSSCONNECTIONS

- A. In the MDF, terminate all risers on wall mounted 110 cross-connect blocks with C5 clips and cross-connect into the building entrance cable 110 block or the services extended from the demarc.
- B. In the IDF's, terminate on a rack mounted 24 port Category 5e RJ-45 patch panel, with one pair terminated per RJ-45 port. The pair shall terminate on pins 4,5 in AT&T T568A connection.
- C. Within the MDF, one (1) 25 pair shall be provided from the 110 wallfield cross-connect block, terminated with C5 clips, to the rack. On the rack, terminate on a 24 port Category 5e RJ-45 patch panel, with one pair terminated per RJ-45 port. The pair shall terminate on pins 4,5 in AT&T T568A connection.
- D. This topology shall permit an analog voice line to be cross-connected to any building workstation outlet using an RJ-45 patch cord.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 5 or less.
 2. Smoke-Developed Index: 50 or less.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-C.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
 2. Communications, Riser Rated: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.3 INTRABUILDING HIGH-COUNT CATEGORY 3 TWISTED PAIR CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Mohawk
 2. Belden
 3. General Cable
 4. Superior Essex
- B. Description: balanced-twisted pair cable, certified to meet transmission characteristics of Category 3 cable at frequencies up to 16MHz.
- C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 3 cables.
- D. Conductors: 100-ohm, 24 AWG solid copper.
- E. Shielding/Screening: Unshielded balanced twisted pairs (UTP).
- F. Cable Rating: Riser Rated, or Plenum if routed exposed in a plenum air return.
- G. Jacket: White or Gray thermoplastic.

- H. Characteristic Impedance: 100 ohm
- I. Characteristic Impedance Tolerance: ± 15 ohm
- J. dc Resistance Unbalance, maximum: 5 %
- K. dc Resistance, maximum: 9.38 ohms/100 m
- L. Mutual Capacitance: 6.6 nF/100 m @ 1 kHz
- M. Operating Frequency, maximum: 16 MHz
- N. Transmission Standards: ANSI/TIA-568-C.2
- O. Safety Voltage Rating: 300 V
- P. Dielectric Strength, minimum: 1500 Vac|2500 Vdc

2.4 TWISTED PAIR CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Crossconnect Wall Mounted 110 Blocks:
 - a. Siemon S110AW2-XX with S110C-5 5-pair connecting clips. Size blocks as indicated on the drawings.
 - b. Panduit
 - 2. Category 5e flat 24 Port Voice Crossconnect Patch Panel
 - a. Panduit
- B. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- C. General Requirements for Cable Connecting Hardware:
 - 1. Twisted pair cable hardware shall meet the performance requirements of Category 5e.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
 - 4. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer
- D. Connecting Blocks: 110-style IDC for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

- 1. Number of Terminals per Field: One for each conductor in assigned cables.

2.5 CABLING IDENTIFICATION

- A. Comply with TIA-606-D and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-D.

2.7 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test cables on reels according to TIA-568-C.1.
- C. Factory test cables according to TIA-568-C.2.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with Section 270528 "Pathways for Communications Systems."
- B. Comply with Section 270529 "Hangers and Supports for Communications Systems."
- C. Comply with Section 270536 "Cable Trays for Communications Systems."
- D. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF COPPER BACKBONE CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. For installation of outside plant interbuilding copper backbone, intercept and enter existing splice case closures in designated manhole. Provide cable splicing in case to extend new backbone to the building. Provide racking, end cap installation, cable labeling, grounding, and reseal splice case. Provide all splicing components and consumables for a complete installation.
- C. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM)," Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section Use lacing bars and distribution spools.
 - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.

10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 11. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
 12. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- D. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications rooms with terminating hardware and interconnection equipment.
 2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 TERMINATION

- A. The termination blocks for voice shall be Approved 110 blocks. For all station wires the 4-position wire clips will be used. For voice risers the 5 position clips should be used.
- B. All Insulation Displacement Connection (IDC), i.e., punchdown, termination's shall be made using the appropriate punch tool for the device. Use of the wrong tool will damage the device and result in installation rejection.

Multi-pair feeder and riser cables shall be terminated following the standard cable color code.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078400 "Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.6 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-D.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling" for cable and asset management software.

- C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- D. Perform tests and inspections.
- E. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- H. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.

END OF SECTION 27 13 13

SECTION 27 13 23 - OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. This section provides the specifications for all the work related to the fiber optic system in the project. The testing of fiber optics is described in another section.
- B. The Owner intends to obtain the fiber optic system installation in a manner similar to the Category 6/6A cabling system from the manufacturer specified in with a minimum 25 year warranty.
- C. The operating temperature range shall be -40°C to $+70^{\circ}\text{C}$ for outdoor cables.

1.3 APPLICABLE DOCUMENTS

- A. The following documents of latest issue form a part of this specification to the extent specified herein.
 - 1. EIA-STD-RS-455: Standard Test Procedures for Fiber Optic, Fibers, Cables, Transducers, Connecting and Terminating Devices.
 - 2. EIA-STD-RS-359: Standard Colors for Color Identification and Coding.
 - 3. MIL-STD-202: Test Methods for Electronic and Electrical Component Parts.
 - 4. MIL-STD-454: Standard General Requirements for Electronic Equipment.
 - 5. MIL-STD-810: Environmental Test Methods and Engineering Guidelines.
 - 6. UL Subject 1666: Standard Flame Test for Flame Propagation Height of Electrical and Optical Cable Installed Vertically in Shafts.
 - 7. EIA/TIA –STD-455 for fiber optic cables.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Indoor Optical fiber cabling
 - 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - a. Corning Cable Systems; Panduit
 - 1) Plenum, Interlocking Armor, 62.5 μm multimode (OM1)
 - 2) Plenum, Interlocking Armor, 50 μm multimode (OM4)
 - 3) Plenum, Interlocking Armor, singlemode (OS2)

- B. Optical fiber patch panels, connectors, patch cords, and related equipment
 - 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - a. Corning
 - b. Panduit

2.2 OPTICAL FIBER CABLES

- A. The optical fiber glass shall be new, unused, and of current design and manufacture.
- B. The optical fiber cable shall be armored and plenum rated.
- C. Fiber Characteristics
 - 1. All fibers in the cable must be usable fibers and meet required specifications.
 - 2. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental requirements of this specification.
 - 3. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.
 - 4. The OM1 multi mode fiber utilized in the cable specified herein shall meet the following:
 - a. Fiber Core Diameter – 62.5 μm
 - b. Fiber Category – OM1
 - c. Wavelengths - 850 nm / 1300 nm
 - d. Maximum Attenuation – 3.4 dB/km / 1.0 dB/km
 - e. Serial 1 Gigabit Ethernet - 300 m / 550 m
 - f. Serial 10 Gigabit Ethernet – 33 m/ -
 - g. Min. Overfilled Launch (OFL) Bandwidth 220 MHz*km / 500 MHz*km
 - h. Minimum Effective Modal Bandwidth (EMB) 220 MHz*km / -
 - 5. The OM4 multi mode fiber utilized in the cable specified herein shall meet the following:
 - a. Fiber Core Diameter - 50 μm
 - b. Fiber Category – OM4
 - c. Wavelengths - 850 nm / 1300 nm
 - d. Maximum Attenuation – 2.80 dB/km / 1.0 dB/km
 - e. Serial 1 Gigabit Ethernet 1000 m / 600 m
 - f. Serial 10 Gigabit Ethernet 550 m
 - g. Min. Overfilled Launch (OFL) Bandwidth 3500 MHz*km / 500 MHz*km
 - h. Minimum Effective Modal Bandwidth (EMB) 4700 MHz*km / -m
 - 6. The single-mode fiber utilized in the cable specified herein shall conform to the following specifications:
 - a. Fiber Type - Single-mode
 - b. Fiber Core Diameter - 8.2 μm
 - c. Fiber Category - OS2

- d. Wavelengths - 1310 nm / 1383 nm / 1550 nm
- e. Maximum Attenuation - 0.4 dB/km / 0.4 dB/km / 0.4 dB/km
- f. Serial 1 Gigabit Ethernet - 5000 m / - / -
- g. Serial 10 Gigabit Ethernet - 10000 m / - / 40000 m

2.3 FIBER TERMINATION CABINETS

- A. This equipment shall be used for the termination of fiber cables.
- B. The equipment shall be rack mountable.
- C. The equipment shall include rear corner slots for cable entry, wire retainers for holding the buffered fiber in place, and fiber storage drums for maintaining a bend radius of 1.5 inches for the buffered fiber.
- D. Provide clear cover over the panel.
- E. The enclosure shall be of 16 ga. cold rolled steel construction with black powder coat finish.
- F. Provide 3-Rack Unit Fiber Termination Cabinets in the building MDF room and IDF Rooms.
- G. Provide adapter panels with Duplex LC inserts, with capacity for 12 fiber strands each.
- H. Both diameters of Multimode fiber may be terminated in the same fiber termination cabinet, provided they are separate within the can (62.5μ on the far left; 50μ on the far right of the LIU) and clearly labeled with the location name of the other end of the fiber.
- I. Multi and single- mode fiber are to be terminated in separate fiber termination cabinets.
- J. Factory-terminated LC pigtails with fusion splices shall be provided.
- K. Provide adapter panels with Duplex LC inserts, with capacity for 12 fiber strands each.

2.4 FIBER OPTIC CONNECTORS

- A. Provide splice-on style UPC LC fiber optic connectors.

2.5 FIBER OPTIC SPLICES

- A. The maximum splice loss for identical fibers shall be 0.3 dB with an average of 0.15 dB for multi-mode and single mode fibers at 850 nm and 1300 nm, respectively.
- B. Provide fusion splice trays as required.

- C. Splice trays shall be anodized aluminum and accept 24 fibers.

PART 3 - EXECUTION

3.1 GENERAL

- A. All fiber installation must be in accordance with all applicable standards and manufacturer's recommendations.
- B. Refer to Testing Section for testing of fiber optic cables.
- C. All fibers shall be properly terminated and tested.

3.2 WARRANTY

- A. All fiber optic systems and components shall be warranted against all defects including material and labor for a specified warranty period in accordance with the required manufacturer's warranty for application assurance, parts, and labor for a minimum of twenty years.

END OF SECTION 27 13 23

SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Category 6a twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. Cable management system.
 - 4. Cabling identification products.
 - 5. Grounding provisions for twisted pair cable.
 - 6. Source quality control requirements for twisted pair cable.
- B. This document describes the products and execution requirements relating to furnishing and installing Telecommunications Cabling. The intent of this section is to define the requirements for the installation of a gigabit copper-cabling infrastructure.
- C. This specification describes the actions to be taken, tasks to be performed and responsibilities of the certified Structured Cabling Contractor in order to provide and install a complete Warranted Horizontal Structured Cabling System. Unless otherwise noted all following sections, which describe such actions, tasks and responsibilities refer to the Contractor.
- D. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Telecommunications contractor.
- E. The horizontal cabling system shall extend from a Telecommunication room located on the floor, or the floor above/below to the information outlet location.
- F. No terms used in this specification are intended to indicate that work or equipment called for shall be less than completely executed or installed or that system shall be less than complete in any respect.
- G. Install the cabling plant constructed in a physical star topology. Serve information outlets from Telecommunication Rooms (TR) by means of unshielded twisted pair (UTP) Category 6 & 6A copper, and terminate per 568B pin configuration. Some locations may exceed beyond the standard 90 meter installation, for these locations the Contractor will use the manufacturer warranted cable solution as specified.

- H. Information outlets shall generally consist of reuse of existing device box/ conduits. All UTP cable, information jacks and the faceplates shall be new. In some locations and where permitted by code the Contractor can install box eliminators and/or surface raceway and boxes.
- I. All horizontal cabling will terminate on rack mounted patch panels in the Telecommunication Room.

1.3 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.
- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between MDF's/IDF's and the equipment outlet in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects,

mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. The maximum allowable horizontal cable length is 295 feet and 345 feet using the extended length cable. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate final rack layout and installation of new telecommunications outlet/connector locations with Owner's Project Manager/Engineer and proposed equipment.
- B. The Drawings diagrammatically show cable routing and outlet locations. The Contractor shall verify the work and shall arrange their work to avoid conflicts. If conditions exist which make it impossible to install work as shown, recommend solutions and/or submit drawings to the Engineer for approval, showing how the work may be installed.
- C. Coordinate new telecommunications outlet/connector locations with location of power receptacles and existing information outlet locations at each work area. New information outlets shall not be installed more than 8" away from a power receptacle.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Patch Panels (fiber, UTP etc.)
 2. Data and Voice Jacks
 3. Faceplates & Mounting Frames
 4. Cable Management Devices
 5. Labeling
 6. All other equipment specified, identified or inferred. Submit complete for Engineer/Owner approval.
- B. Shop Drawings:
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

3. Cabling administration Drawings and printouts.
4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.
 - g. Mechanical, electrical, and plumbing systems.
- C. Twisted pair cable testing plan.
- D. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration, and faceplates for color selection and evaluation of technical features.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

- A. When all work has been completed and prior to final acceptance, the Contractor shall furnish to the engineer a complete set of reproducible contract marked drawings clearly showing all contract work "as-built". Prior to delivery each drawing shall be signed and dated by the Contractor's project manager attesting to the accuracy. After review and approval from the Owner, the Contractor will provide an as-built drawing in each Telecommunication room.
- B. Contractor will document daily the routing of cabling, sleeve placement and any pertinent as-built information. The Owner Project Manager and/or Engineer can request to view these documents upon any visit. If documents are not current the Contractor will rectify the condition and submit accurate documents the following work day.
- C. Mark up a clean set of Specifications to indicate approved substitutions, change orders, and actual equipment and materials used.
- D. Maintenance Data: For all furnished items to be include in maintenance manuals.

- E. Complete warranty documentation.
- F. Maintenance Data: For splices and connectors to include in maintenance manuals.
- G. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media or compact disk, complete with data files.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, and field testing program development by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications:
 - 1. Manufacturer Approved Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 WARRANTY

- A. The Warranty combines a 25-year extended product warranty with a 25-year applications assurance warranty. Manufacturer will provide the warranty directly to the Owner.
- B. The contractor shall provide a (1) one-year warranty on the physical installation.
- C. Provide complete warranty information for each item to include date of beginning of warranty, names, addresses, telephone numbers, and procedures for filing a claim to obtain warranty service.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.12 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.13 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- D. Grounding: Comply with TIA-607-C.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- C. RoHS compliant.

2.3 INDOOR/OUTDOOR RATED CATEGORY 6A TWISTED PAIR CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Panduit TX6A, Cat 6A, 23 AWG, U/UTP, CMP, Indoor/Outdoor, Black PUO6AS04BL-G

- B. Description: 100-ohm, four-pair UTP covered with a thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-C.2 for performance specifications.
 - 3. Comply with TIA/EIA-568-C.2, Components.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
- C. Standard: Comply with OUTDOOR USE ANSI/ICEA S-56-434, BROADBAND OUTDOOR USE ANSI/ICEA S-99-689, INDOOR/OUTDOOR USE ANSI/ICEA S-100-685 and TIA-568-C.2 for Category 6a cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP)

2.4 CATEGORY 6A TWISTED PAIR CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Panduit TX6A Copper Cable, Cat 6A, 23 AWG, UTP, PUP6AHD04xx-G, CMP Plenum rated
 - a. Data/Voice/Wireless: Blue
 - b. Biomed: Orange
- B. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
- C. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Unshielded twisted pairs (UTP).
- F. Cable Rating: Plenum.

2.5 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6 or Category 6a.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.

- C. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Panduit Mini-Com Flush Patch Panel, CPP48FMWBLY, black, 48 port, 2 RU
 - 2. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 3. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
- D. Patch Cords: Factory-made, four-pair cables; terminated with an eight-position modular plug at each end. Meet TIA Category 6A component specifications in ANSI/TIA/EIA-568-C.2-1 100% factory tested.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following listed:
 - a. Panduit TX6A 10Gig UTP Patch Cords Patch Cord with MaTriX Technology.
 - 1) Station Patch Cables
 - a) Data/VoIP: Blue
 - b) Wireless: Yellow
 - c) Biomed: Orange
 - d) A/V: Purple
 - e) Printers: Green
 - 2) MDF/IDF Patch Cables
 - a) Data/VoIP: Blue
 - b) Wireless: Yellow
 - c) Biomed: Orange
 - d) A/V: Purple
 - e) Printers: Green
 - 2. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 3. Provide (1) minimum 3' Category 6A plenum rated patch cord for each installed wireless access points, IP ceiling speakers, security cameras, or other installed ceiling device served from the ceiling plenum.
 - 4. Provide (1) Category 6A patch cord in the telecom room for each cable terminated at the patch panel. Field verify final lengths of patch cords provided in the Telecom Rooms to avoid excessive slack. Provide any lengths required. Provide small diameter patch cords with 26 or 26 AWG conductors.
 - 5. Provide (1) Category 6A patch cord at the workstation and device end for each cable terminated. Provide 10 ft patch cords at workstation outlets. Field verify final lengths of patch cords provided to serve equipment and devices. Provide any lengths required and confirm patch cord colors with the Owner.

E. Jacks and Jack Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Panduit Mini-Com UTP RJ45 Cat 6A TG Jack Module, CJ6X88TG
2. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
3. Designed to snap-in to a patch panel or faceplate.
4. Standard: Comply with ANSI/TIA-568.2-D (September 2018) Balanced Twisted Pair Communications and Components Standards.
5. Marked to indicate transmission performance.

F. Faceplates:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Panduit Mini-Com
 - b.
2. Stainless Steel Faceplates: sizes, types, or port counts as indicated on the drawings
3. Plastic Faceplates: sizes, types, or port counts as indicated on the drawings
4. Systems Furniture Plates: sizes, types, or port counts as indicated on the drawings
5. Decora and 106 Adapter Frames: sizes, types, or port counts as indicated on the drawings
6. Plenum rated dual port surface mount box for installation above finished ceiling for wireless access points, or other equipment panel locations:
 - a. Panduit Mini-Com Surface Mount Box, CBXQ2WH-A, two ports, white
7. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
8. Provide Stainless Steel Faceplates at all wall device locations unless directed by the Architect to provide another finish and color to match building aesthetics. Provide any finish, material, or color required by the Architect.
9. Legend:
 - a. Machine printed, in the field, using adhesive-tape label.
 - b. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-D and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

- B. Comply with TIA-607-D.

2.8 SOURCE QUALITY CONTROL

- A. Factory test cables on reels according to TIA-568-C.1.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Security devices (ePhones, CCTV, etc.) do not require a different color cable (horizontal wiring or patch). However, they are to be marked using light red icons at each Patch Panel port.
- B. For each fiber termination cabinet and each voice-trunk panel installed, a 2 RU cable manager will be installed. For every 24-ports of data network equipment, a 1 RU cable manager will be used. In addition, 6"-7" wide x 13" deep vertical cable management will be installed at the ends/between all racks. If space does not permit the use of 6" wide cable management, 3"-5" may be used on the ends only.
- C. All station wiring is to be terminated in a patch panel. Voice trunk and riser panels may be Category 3. All new patch panels are to be Panduit. Under no circumstances are 110/66 wall-blocks to be used in IDF's for voice. A patch panel will be placed at the top of each communications rack, or if a fiber can is also housed in the rack, under it for Voice Trunk ports only. The quantity of Voice Trunk ports will be divided equally to each rack. The Voice Trunk panels will be color Blue to differentiate them from the station wiring panels. Station wiring panels will be black. Alternatively, blue or black "icons" may be used on the patch panels to differentiate between Trunk and Station ports. All panels, whether Category 3 or 6+, must support the use of icons. As with MDFs, multimode and single mode fiber will be terminated in separate cans. 50 μ and 62.5 μ fiber may be terminated in the same can, provided they are separated and clearly labeled. 62.5 μ fiber will be terminated on the far left of the LIU, 50 μ on the far right. If space does not permit this, cabling is not to make assumptions on placement; placement must be clarified with Temple University Health System.
- D. The Health System has standardized on Aruba wireless Access Points for wireless networking connectivity. For best coverage, these units need to be mounted parallel to the floor/ceiling. Wall mounting will require L-brackets. All deviations from this must be approved through Networking Services. Networking Services will provide locations for all wireless array installations or relocations.

- E. When mounting a wireless array to an acoustical ceiling tile (ACT), the mounting bracket is to be centered on the tile and not attached to the ceiling grid. To add support to the tile, a 24" length of metal stud is to be placed above the tile such that it sits in the ceiling grid. The stud segment will have a hole punched in it to allow the necessary cabling to pass through. Cut ends of the stud will be covered with tape to eliminate sharp edges.
- F. The stud will also be chained in the same fashion that a light fixture would be secured in a suspended ceiling.
- G. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables, except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- H. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- I. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATCH CORDS

- A. Provide patch cords for each of Category 6/6A link, with one workstation end patch cord, and one telecom room end patch cord.
- B. Coordinate lengths and colors of patch cords within the telecom room to match telecommunications equipment rack layouts. Excessive lengths are unacceptable.
- C. Coordinate final lengths and colors of patch cords furnished for workstations and devices with Owner.
- D. Install patch cords and patch in network devices as directed by the Owner.

3.3 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 270529 "Hangers and Supports for Communications Systems."
- D. Comply with Section 270536 "Cable Trays for Communications Systems."

- E. Drawings indicate general arrangement of pathways and fittings.

3.4 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. General Requirements for Cabling:
 - 1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
 - 2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. MUTOA shall not be used as a cross-connect point.
 - 7. Consolidation points may be used only for making a direct connection to equipment outlets:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.
 - 8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 - 11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
 - 12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 13. In the communications equipment room, install a 10-foot long service loop on each end of cable.
 - 14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078400 "Firestopping."

- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.6 GROUNDING

- A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- B. Comply with TIA-607-E and NECA/BICSI-607.
- C. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-D. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-D.
- C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 1. Visually inspect UTP cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
 2. Visually confirm Category 6 & 6A, marking of outlet/connectors, and patch panels.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 4. UTP Performance Tests:
 - a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA- 568-C.1 and TIA/EIA-568-C.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.

5. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 6. Voice Tests: These tests assume that dial tone service has been installed by Owner. Connect to the information outlet, go off-hook and listen and receive a dial tone.
 7. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the information outlet have Owner/User log onto the network to ensure proper connection to the network.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 27 15 13

SECTION 27 15 33 - COMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. CATV coaxial cable.
 - 2. Coaxial cable hardware.
 - 3. Grounding.
 - 4. Identification products.
 - 5. Testing

1.3 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. LAN: Local area network.
- E. RCDD: Registered Communications Distribution Designer.

1.4 COAXIAL HORIZONTAL CABLING DESCRIPTION

- A. Coaxial horizontal cabling system shall provide interconnections between the MDF/IDF and the equipment outlet in the telecommunications cabling system structure. Cabling system consists of horizontal cables, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Nominal OD.
 - 2. Minimum bending radius.
 - 3. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For coaxial cable, splices, and connectors to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 1. Test each coaxial cable on the reel for continuity.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-E.
- C. Grounding: Comply with TIA-607-E.

2.2 GENERAL CABLE CHARACTERISTICS

- A. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. CATV Plenum Rated: Type CATVP complying with NFPA 262.

2.3 CATV COAXIAL CABLE

- A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.
- B. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article.
- C. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Belden
 - 2. Commscope

3. General Cable

D. RG-6/U: UL Type CATVP.

1. Quad shield.
2. No. 18 AWG, solid, copper-covered steel conductor.
3. Plenum rated.
4. Gas-injected, foam-PE insulation.
5. Jacketed with white PVC or PE.
6. Suitable for indoor installations.

E. RG-11/U: UL Type CATVP.

1. No. 14 AWG, solid, copper-covered steel conductor.
2. Plenum rated. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg F (minus 40 to plus 30 deg C).
3. Gas-injected, foam-PE insulation.
4. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
5. Jacketed with sunlight-resistant, white PVC or PE.

F. ½" Hardline: UL Type CATVP.

1. Copper-clad aluminum center conductor.
2. Plenum rated.
3. Aluminum outer conductor
4. FFEP dielectric material
5. Jacketed with sunlight-resistant, white fire retardant PVC

2.4 COAXIAL CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

B. Coaxial-Cable Connectors

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Belden Snap-N-Seal or approved equivalent.
2. Compression Type F, 75 ohms
3. Physical Properties
 - a. Nut, Post and Collar: Brass
 - b. Nut and Collar Finish: Nickel Tin
 - c. Post Finish: Tin Plated
 - d. O-Rings: Ethylene Propylene

4. Electrical Properties

- a. Return Loss: ≥ -30 dB up to 1GHz Typical
- b. Insertion Loss: ≤ -0.18 dB up to 1GHz Typical
- c. RFI Shielding: -90 dB Typical (60% Bonded Foil)

5. Mechanical Properties

- a. Cable Retention: 40 lbs min.
- b. Complies to SCTE IPS-SP-401
- c. Cable Insertion Force: <20 lbs Typical

6. Environmental Properties

- a. Temperature Rating: -40°F (-40°C) to 140°F (60°C)
- b. Moisture Migration: Passes ANSI/SCTE 60 2004

C. Jacks and Jack Assemblies: Modular, color-coded, with female Type F connectors.

D. Patch Cords: Factory-made; terminated with a male Type F connector at each end.

2.5 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-D.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-D and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate cabling installation with the demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. All Video cabling (RG-6 for distances less than 150', RG-11 for distances greater than 150') will be terminated at a wall field, where Health System Cable TV distribution is located. One pair of RG-11 cables will be run between an MDF and any IDF serviced by it.
- B. Terminate using the proper tap for the cable size per the Cable Company's current standards. This should be verified at time of installation. The placement within the Data Center is not specifically defined, but there is an area set aside for coax.
- C. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- E. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

- A. Comply with Section 271100 "Communications Equipment Room Fittings." Comply with requirements in Section 270528 "Pathways for Communications Systems" for installation of conduits and wireways.
- B. Comply with Section 270529 "Hangers and Supports for Communications Systems."
- C. Drawings indicate general arrangement of pathways and fittings.
- D. Comply with NFPA 70 for pull-box sizing and length of conduit and number of bends between pull points.
- E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.4 INSTALLATION OF COAXIAL HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend coaxial cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

- A. Comply with requirements in Section 078400 "Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607-C and NECA/BICSI-607.
- C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections

C. Tests and Inspections:

1. Visually inspect coaxial jacket materials for NRTL certification markings.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test coaxial horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, polarity between conductors., length, splitter/mechanical connector identification, overall Pass/Fail. Test operation of shorting bars in connection blocks. Test cables after termination.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 27 15 33

SECTION 275223 - NURSE CALL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Sections included:
 - 1. Equipment Cabinet
 - 2. Nurse Call Console
 - 3. Patient Stations
 - 4. Staff and Duty Stations
 - 5. Corridor Dome Lights
 - 6. Peripheral Equipment

1.3 SYSTEM DESCRIPTION

- A. This performance specification provides the minimum requirements for a supervised audio-visual Voice over IP-based Nurse Call System. The System shall include, but not be limited to all equipment, materials, labor, documentation, and services necessary to furnish and install a complete, operational Voice over IP-based Nurse Call System. The System shall have full duplex audio as well as "push to talk" control for high-noise areas. The System shall comply in all respects with all pertinent codes, rules, regulations, and laws of the hospital authority and local jurisdiction. The System shall comply in all respects with the requirements of the specifications, Manufacturer's recommendations and Underwriters Laboratories Inc. (UL) Listings.
- B. Each System shall be capable of supporting in excess of 500 Patient Stations (>1,000 beds) and 5,000 Peripheral Stations. The System shall support networking of up to three systems of this size to a single integrated platform for:
 - 1. Wireless communications system(s)
 - 2. Reporting Database
 - 3. ADT Integration
 - 4. Wireless Locating
 - 5. Electronic Whiteboard
 - 6. PC Staff Console (List View and Floorplan view) applications
 - 7. Patient/Staff Assignments
 - 8. Automatic/Manual Messaging
- C. It is further intended that upon completion of this work, the Owner be provided with complete information and drawings describing and depicting the entire System(s) as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the System(s) at a future date, and complete documentation of System(s) testing.

- D. No interpretations of the meaning of the bid documents will be made to any Bidder orally. Each request for such interpretation shall be made to the Engineer in writing.

1.4 SUBMITTALS

- A. General Submittal Requirements:

- 1. Shop Drawings shall be prepared by persons trained and certified by manufacturer of the nurse call system.

- B. Product Data: For each type of product indicated.

- C. Shop Drawings: For nurse call system. Include plans, elevations, sections, details, and attachments to other work.

- 1. Include performance parameters and installation details of each system component.
 - 2. Locate devices according to the manufacturer's recommendations and standards.
 - 3. Include floor plans to indicate final device locations and cable types and conduit sizes.

- D. Qualification Data: For qualified Installer.

- E. Field quality-control reports.

- F. Operation and Maintenance Data: For nurse call systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data", include the following:

- 1. Provide "Record As-Built Documents"
 - 2. Provide "Maintenance, Inspection and Testing Records"
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 - 3. Manufacturer's required maintenance related to system warranty requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this project.

- B. Source Limitations for Nurse Call System and Components: Obtain the system from a single source from a single manufacturer.

- C. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA70 by a qualified testing agency and marked for intended location and application.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Nurse Call System Manufacturers include:
 - 1. Hill Rom
- B. All equipment and components shall be the Manufacturer's current model. The materials, appliances, equipment, and devices shall be tested and listed by a nationally recognized approval agency for use as part of a Nurse Call System. The Manufacturer's representative shall be responsible for the satisfactory installation of the complete System.
- C. The Contractor shall provide, from the acceptable Manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications. Equipment or components, which do not provide the performance and features required by these specifications, are not acceptable, regardless of manufacturer.
- D. The Manufacturer of the System equipment shall be regularly involved in the design, manufacture, and distribution of all products specified in this document. These processes shall be monitored under a quality assurance program that meets ISO requirements. The Manufacturer shall have the financial stability to provide project financing/lease options to the Owner if desired.
- E. All System components shall be the cataloged products of a single Supplier. All products shall be listed by the Manufacturer for their intended purpose. GE Security - Sound & Communications products constitute the minimum type and quality of equipment to be installed.
- F. All connected field electronics shall be both designed and manufactured by the same company, and shall be tested to ensure that a fully functioning System is designed and installed. The VoIP-based Nurse Call System shall utilize Ethernet topology, switches, gateways, and devices. These devices shall make up a UL 1069 Listed nurse call LAN/WAN.

2.2 ALTERNATES

- A. Strict conformance to this specification is required to ensure that the installed and programmed System will function as designed, and will accommodate the future requirements and operations of the building Owner. All specified operational features shall be met without exception.
- B. The authorized Representative of the Manufacturer of the equipment shall be responsible for the satisfactory installation of the complete System.
- C. All equipment and components shall be the Manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approval agency for use as part of an audio-visual Voice Over IP-based Nurse Call System. The authorized Representative of the Manufacturer shall be responsible for the satisfactory installation of the complete System.

- D. All Annunciators, Staff Consoles, IP Switches, Station Gateways, Telephone Gateways, IP Devices, Patient Stations, Dome Lights, and Peripheral Devices shall be provided by the same System Supplier, and shall be designed and tested to ensure that the System operates as specified. All equipment and components shall be installed in strict compliance with the Manufacturer's recommendations.
- E. Alternates to the equipment specified will be considered only if all sections of the performance specification are met. Any deviations from System performance as outlined in this specification will be considered only when the following requirements have been met:
 - 1. A complete description of proposed alternate System performance methods with three (3) copies of working drawings thereof shall be submitted to the Engineer for approval not less than ten (10) calendar days prior to the scheduled date for submission of bids. The Supplier shall submit a point-by-point statement of compliance for all sections in this specification. The statement of compliance shall consist of a list of all paragraphs within these sections. Where the proposed System complies fully with the paragraph, as written, placing the word "comply" opposite the paragraph number shall indicate such. Where the proposed System does not comply with the paragraph as written, and the Supplier feels the proposed System will accomplish the intent of the paragraph, a full description of the function, as well as a full narrative description of how its proposal will meet its intent, shall be provided. Any submission that does not include a point-by-point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed System does not comply.
 - 2. The acceptability of any alternate proposed System shall be the sole decision of the Owner and the Project Engineer.

2.3 REFERENCES

A. General (References)

- 1. All work and materials shall conform to all applicable Federal, State, and local codes and regulations governing the installation. If there is a conflict between the referenced standards, federal, state, or local codes, and this specification, it is the Bidder's responsibility to immediately bring the conflict to the attention of the Engineer for resolution. National standards shall prevail unless local codes are more stringent. The Bidder shall not attempt to resolve conflicts directly with the local authorities unless specifically authorized by the Engineer.
- 2. System components proposed in this specification shall be listed by Underwriters Laboratories, Inc. (UL) to operate together as a System. The Supplier shall be responsible for filing all documents, paying all fees (including, but not limited to plan checking and permits), and securing all permits, inspections, and approvals. Upon receipt of approved drawings from the authority having jurisdiction, the Supplier shall immediately forward two sets of drawings to the Owner. These drawings shall either be stamped as approved or a copy of the letter stating approval shall be included.

2.4 DEFINITIONS

A. ADT: Admission Discharge Transfer System

- B. AFF: Above Finished Floor
- C. AHJ: Authority Having Jurisdiction
- D. Approved: Unless otherwise stated, materials, equipment, or submittals approved by the Authority or AHJ
- E. Circuit: Wire path from a group of devices or appliances to a control module
- F. DL: Dome Light
- G. ESM: Event Subscription Manager
- H. HL7: Health Level 7 protocol
- I. IP: Internet Protocol
- J. IPN: IP Network
- K. PD: Peripheral Device
- L. PN: Peripheral Network
- M. PSpkr: Pillow Speaker
- N. SC: Staff Console (Master Station)
- O. UL or ULI: Underwriters Laboratories, Inc.
- P. UL Listed: Materials or equipment Listed and included in the most recent edition of the UL Equipment Directory

2.5 SYSTEM DESCRIPTION

- A. General
 - 1. The System shall be network-based and incorporate decentralized, distributed intelligence architecture. This intelligent architecture shall be built on an IP (Internet Protocol) network. The System shall allow both data and voice to be distributed over a common network infrastructure, which is consistent with the communication industry. Communication devices on the network will utilize standards-based protocols. The System shall also provide a means of interoperability with 3rd party wired and wireless network devices within the facility, including PCs, PDA's, phones, databases, pagers, etc.
 - 2. Each System shall be capable of supporting in excess of 500 Patient Stations (>1,000 beds) and 5,000 Peripheral Stations. The System shall support networking of up to three Systems of this size.
 - 3. The System shall consist of (include):
 - a. Staff Consoles and Annunciator Panels with color touch screen LCD panels

- b. Station Gateways
 - c. Ethernet Switches/powered distribution hubs
 - d. Single and Dual Patient Stations
 - e. Configurable Single-Gang Push/Pull Type Peripheral Devices
 - f. Single-Gang Dual Aux Input Stations with optional electrical isolation
 - g. 1, 2, and 4-Section LED Corridor Lights
 - h. Network Bridge and Configuration Software
 - i. Telephone Gateway
4. The System shall be capable of integrating to:
- a. The hospital's in-building wireless telephone systems
 - b. The hospital's pocket paging systems
 - c. Hospital data gathering and reporting software
 - d. Staff locating systems, wireless call cords, CCTV switching controls, and door access controls
 - e. Patient-to-staff assignments, wandering patient alarm systems, bed exit and/or fall prevention alarm systems, and patient equipment calls
 - f. Marquee display panels, PC monitors, and large screen monitors such as Flat Panel LCD or Plasma displays
5. The System shall be capable of Hill-Rom and/or Stryker bed side-rail communication compatibility including visual and audible annunciation of a disconnected bed.
6. It shall be possible to configure the System using a modular, flexible GUI application that provides the system administrator the ability to manage, (add, delete, modify) and diagnose information within the nurse call network.
7. The System shall not rely on any computer for operation. Systems requiring a PC to be connected for operation shall not be accepted.
8. The system architecture shall not require external power supplies. Systems requiring power supplies to be installed separately from the control equipment shall not be accepted.

2.6 NURSE CALL CONSOLES

- A. The Console is a primary point of contact among users of the system. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network.
- B. As a user interface, the Nurse Call Console alpha-numerically displays incoming calls from stations and connected healthcare equipment, and provides a means for the operator to prioritize and respond to selected events. As an audio device, it provides audible signaling functions and facilitates two-way full-duplex staff/patient and staff/staff communications.
- C. The Nurse Call Console shall provide visual identification of the calling station(s) by room number, bed identification, priority, station type or call type. Staff Console audible annunciation shall indicate priority level. Incoming calls shall be displayed on the color display in the colors for their associated priority levels. Staff Console shall also display an elapsed time for each pending call.
- D. The Nurse Call Console shall be IP-based, utilizing Voice over IP technology.

- E. The Nurse Call Console shall have a 5.7" backlit color touch LCD screen.
- F. The touch screen shall utilize programmable soft keys as opposed to a mechanical dial/touchpad.
- G. Nurse Call Console display shall provide an adjustable tilt mechanism for viewing clarity.
- H. Intercom audio between the Nurse Call Console and any station in the System shall be full duplex. Systems providing only one-way (half-duplex) audio shall not be accepted.
- I. The Nurse Call Console shall connect to the nurse call LAN/WAN utilizing CAT5/5e/6 cable and powered Ethernet. No separate power supply or wiring shall be used.
- J. The call pending screen on the Nurse Call Console shall allow six calls to be visible at a time and provide a simple scrolling function to view additional calls when more than six pending calls are present. Pending calls shall be displayed in priority order regardless of the order in which they are received.
- K. The Nurse Call Console shall have the ability to "automatically select" incoming calls in order of priority, or to allow the user to select what call to answer from the pending calls list.
- L. The user shall have the ability to adjust the volume of the Console incoming call tones.
- M. The Nurse Call Console shall be able to call other Consoles and Annunciators on the same network. Console to Console audio shall be full VoIP, full duplex.
- N. Nurse Call Consoles and Annunciators shall be programmable to receive and display selected call priorities from desired areas, or to delay selected calls for a programmable interval.
- O. Nurse Call Consoles shall have the ability to adjust independent talk and listen volume levels via easy-to-use touchscreen controls. These settings shall be adjustable on a room-by-room basis. Systems using group or zone-wide audio adjustments shall not be accepted.

2.7 ANNUNCIATOR PANELS

- A. The Annunciator provides a primary call display for users of the system. It operates as both a user interface and a communications device that sends and receives data and audio signals over the IP network.
- B. As a user interface, the Annunciator alpha-numerically displays incoming calls from stations and connected healthcare equipment, and provides a means for the operator to prioritize and respond to selected events. As an audio device, it provides audible signaling functions and facilitates two-way full-duplex staff/patient and staff/staff communications.
- C. The Annunciator shall provide visual identification of the calling station(s) by room number, bed identification, priority, station type or call type. The Annunciator shall indicate priority level. Incoming calls shall be displayed on the color display in the colors for their associated priority levels. Annunciators shall also display an elapsed timer for each pending call.
- D. The Annunciator Panel shall be IP-based, utilizing Voice over IP technology.

- E. Annunciators shall have a 5.7" backlit color touch LCD screen.
- F. The touch screen shall utilize programmable soft keys as opposed to a mechanical dial/touchpad.
- G. Annunciators shall provide intercom capability via panel speaker and microphone. Intercom audio between the Annunciators and any station in the System shall be full duplex. Systems utilizing one-way (half-duplex) audio shall not be accepted.
- H. The Annunciator shall connect to the nurse call LAN/WAN utilizing CAT5/5e/6 cable and powered Ethernet. No separate power supply or wiring shall be used.
- I. Annunciator shall allow connection of a handset for locations where privacy is of concern.
- J. The Annunciator shall be able to call other Nurse Call Consoles and Annunciators on the same network. Nurse Call Console/Annunciator to Nurse Call Console/Annunciator audio shall be full VoIP, full duplex.
- K. Consoles and Annunciators shall be programmable to receive and display selected call priorities from desired areas, or to delay selected calls for a programmable interval.
- L. The call pending screen on the Annunciator shall allow six calls to be visible at a time and provide a simple scrolling function to view additional calls when more than six pending calls are present.
- M. The Annunciator shall have the ability to "automatically select" incoming calls in order of priority, or to allow the user to select what call to answer from the pending calls list.

2.8 NETWORK EQUIPMENT

- A. Switches and Gateways
 - 1. All control equipment shall be IP-based, utilizing IP Switches and gateways for connection to room devices. These devices shall make up a UL 1069 Listed Nurse Call LAN/WAN. The controller equipment shall mount in a standard 19" rack to be shared with the facility's IT equipment or shall mount in an independent rack. The IP switches and gateways shall have power supplies to support all field devices internally. Systems using a proprietary enclosure/card cage for central equipment and/or requiring power supplies apart from the control equipment shall not be accepted.
 - 2. IP Switches shall be networked, allowing all units/floors of a facility to connect as a single System. Each nurse call system shall connect to the hospital's network via a software bridge that isolates the hospital network from the nurse call network to maintain UL requirements. This connection to provide connectivity to supplemental features such as display screens, an ADT system, wireless telephones, pocket pagers, wireless Voice over IP devices, and a reporting database.

2.9 INTEGRATIONS

- A. Pocket Pager Interface

1. The Nurse Call System shall allow connection to the hospital's in-house pocket pager systems. This integration shall allow calls from patients to automatically send text messages to their assigned caregiver(s). The pager display must show the caregiver the bed number of the call, the call type/priority, and optionally the unit name or patient name (with presence of ADT interface).
2. The pocket pager integration shall allow no less than three levels of staff, plus a charge nurse and a "group," to be assigned to each patient/bed or call priority. These assignments shall be performed via the client-based assignments software. The rollover times between assigned caregivers shall be definable by the facility. Each Nursing Unit shall be have the ability to define rollover times independent of other department requirements.
3. A call escalation manager shall manage automatic messaging to the pocket pagers. The call escalation manager shall also provide group page functions that allow any defined group of devices to receive any selected call type(s).
4. The call escalation manager shall also provide the ability to transmit a Call Cancel in the event of a call being attended to; remaining staff not yet on-site can be notified that the situation has been attended to.
5. The pocket pager integration shall allow device failures in the Nurse Call System to generate an automatic page to a Biomed device or team of devices.
6. The pocket pager integration shall allow housekeeping events to generate an automatic page to a Housekeeping device.

2.10 TELEPHONE GATEWAY

- A. The nurse call network shall be equipped with an SIP compatible device that has analog trunk ports for connection to PBX extension ports.
- B. The telephone gateway shall provide access to wired telephones that are connected to the hospital's telephone system. It shall allow wired or wireless telephones to communicate with Patient and Staff Stations. The call information shall include the room and bed identification, call type, and patient name (if available from ADT). The telephone gateway shall communicate using standard telephone protocols.
- C. The telephone gateway shall be programmable via any PC that is connected to the network, either onsite or remotely. The gateway shall support up to 512 stations on the Nurse Call System. The gateway shall accept multiple inputs and outputs to connect to multiple Systems on site.

2.11 MAP VIEW CLIENT SOFTWARE

- A. Map View Client Software shall be available to provide a map view of each nursing unit via login to supplement the Staff Console. This client shall display the following information:
 1. Staff list shall sort by level, name, device type (phone/pager), and device ID
 2. 3D unit map
 3. Staff location via multi-colored icons
 4. Call activity via room color change
 5. Reminder icons
 6. Activity history per patient/bed including:

- a. Calls
 - b. Audio connection to room
 - c. Reminders (with optional Reminder reason)
 - d. Text messages (automatic and manual)
 - e. Staff Arrivals
- 7. Location list shall be sortable by level, name, location or battery status
- 8. Patient census list shall be sortable by patient name, bed number
- 9. Unique icon for each device type (pager, phone, team)
- 10. Display bed-by-bed, three levels of assigned staff plus charge and active teams
- B. Rooms shall display call location and call type. Call colors shall be configurable to match Corridor Light settings by priority.
- C. It shall be capable of messaging the caregiver (one of three levels assigned plus charge or team) from the Map View screen.
- D. Reminder colors shall be configurable to indicate reminder and match Corridor Light settings.
- E. Each Map View login shall be capable of having a unique reminder reason and message list. Systems requiring all users to share the same remind and messaging list shall not be accepted.
- F. Staff presence icons shall be configurable to match staff level/type. Up to nine colors/levels shall be available.
- G. The Map View shall be configurable on site using a pick and place set up wizard. Systems requiring CAD files to be imported or graphical software for creation of unit maps shall not be accepted.
- H. The Map View Client shall automatically show room summary for any selected room.
- I. The Map View Clients shall be password protected. The login password shall determine the units visible and view preferences for each client.
- J. The Map View Client shall be capable of running on an existing PC at the nurse station or on a PC dedicated to Nurse Call System functions. Systems requiring a dedicated PC for the functions listed shall not be accepted.

2.12 PATIENT STATIONS

- A. Patient Stations are a primary point of two-way communication between patients and staff. Equipped with three call buttons and a cancel button, they offer users an easy-to-operate means of placing calls on the patient-staff communications system. With a built-in speaker and microphone, these devices also provide patients with the means of opening a full-duplex channel of audio communications with attending staff, and vice versa. On-board LEDs provide operational feedback as well as status indication.

- B. Smart Patient Stations provide separate 18-pin receptacles for the connection of pillow speakers. Each station also comes equipped with two ¼" (0.64 mm) receptacles that can be programmed to accept either an input from auxiliary equipment, or a bed call cord.
- C. Patient Stations shall provide a durable 18-pin pillow speaker receptacle and two user-configurable ¼" jacks for use with call cords or as non-latching device monitoring (auxiliary) inputs.
- D. Stations shall provide four buttons that are field configurable allowing Owner to define call priorities without ordering custom stations. Configuration software shall allow the Owner to select from a list of button templates.
- E. Systems unable to provide Patient Stations that support pillow speaker(s), bed interface(s), and up to two auxiliary inputs from the Patient Station shall not be accepted.
- F. Removal of the pillow speaker, bed interface or call cord/auxiliary alarm cable shall generate a cord out call.
- G. Stations shall NOT require the use of "dummy" plugs for any receptacles including call cord/auxiliary device, pillow speaker, and bed interface connections. Systems requiring a dummy plug to be inserted to cancel cord out calls shall not be accepted.
- H. Patient Stations must provide the ability to intentionally remove a device (call cord, pillow speaker, bed interface) without placing a call to the System. When this feature is activated, the removal of any of these items shall not send a cord out call.
- I. Stations must provide a cleaning mode to allow housekeeping to clean station surfaces without generating false calls. Activating cleaning mode shall temporarily disable the front panel buttons for a defined period of time.
- J. It shall be possible to cancel a call from any cancel button within a patient room by linking stations when configured to do so and code allows.
- K. Patient Stations shall be configurable for custom call types without custom ordering devices from the Manufacturer or replacing devices.
- L. Patient Stations shall have separate speaker and microphone to support full duplex audio. Systems using half-duplex audio (voice operated switch) shall not be accepted.
- M. Patient Stations shall include two independent auxiliary inputs (1/4" jacks) capable of supporting either latching medical equipment and/or non-latching call cords. Staff members shall be able to configure these inputs for latching or non-latching inputs at the station via a button press on the face of the station. The Patient Stations shall provide a visual indication of the auxiliary input status being set.
- N. Patient Stations shall have a status LED to indicate call and communication status.

- O. Each Patient Station button shall have a dedicated LED to indicate that the button has been pressed or is actively indicating a call. Patient Stations using a single LED to indicate the pressing of any button will not be accepted.
- P. Patient Stations shall support a staff follow mode that, when activated, alerts staff to calls from other stations by an audible tone at the station in their current location. The staff follow tone shall match the tone of the incoming call priority. NOTE: "Staff Follow" requires "Off Duty" mode.
- Q. Patient Stations shall NOT have DIP switches that require manual setting by field personnel. Each Patient Station shall have a preconfigured identification number that specifies the station type automatically. Stations utilizing manual DIP switches shall not be considered.
- R. Patient Stations shall be hot swappable and not require system shutdown or removal of power prior to replacement.
- S. Patient Stations shall support simultaneous input of pillow speaker and bed. If either connection is removed, audio must automatically transfer to the remaining device or to the on-board station speaker.
- T. Volume levels for each Patient Station shall be adjustable on a station-by-station basis. Universal settings, or settings that affect an entire wing or floor, shall not be accepted.
- U. All Patient Stations shall be supervised.
- V. Each Patient Station shall connect to the System wiring via a single RJ-45 connector. All connections to television and light controllers shall be via removable lever connectors providing simple, hot swappable serviceability.
- W. Patient Stations shall provide on-board lighting to provide visibility in dark rooms.

2.13 CALL CORDS

A. Single Call Cords

- 1. Provide call cords as required. The call cord shall have a heavy duty, molded, ¼" connector, a flexible PVC jacketed cable, and a molded, flame retardant, ABS switch housing. The switch shall be the momentary contact type. The cord shall be 6' in length, have an integrated sheet clip, and be suitable for ethylene oxide sterilization.

B. Pillow Speakers

- 1. Provide one (1) pillow speaker for each Single Patient Station and two (2) pillow speakers for each Dual Patient Station. The pillow speakers shall have an 18-pin, durable plug that can withstand accidental removal from station plug without damage to pillow speaker or patient station. The housing shall contain the nurse call button, a speaker, and buttons for TV volume control and channel control in a molded, flame-retardant, ABS housing. The cord shall be 8' in length and have an integrated sheet clip.

2.14 STAFF, DUTY STATIONS

- A. Staff/Duty Station features shall be identical in operation to the Patient Station with the exception of the call cord, pillow speaker, and bed interface receptacles.
- B. Annunciation tones at Staff/Duty Stations must be identical to the tones generated by the Nurse Call Console for each priority to clearly identify call types. Systems having duty tones that are not identical to tones generated by the Nurse Call Console shall not be accepted.

2.15 PERIPHERAL STATIONS (TOILET STATION, STAFF/DUTY STATION, PRESENCE STATION, ETC.)

- A. Peripheral Stations are addressable initiating devices that provide patient room call-for-assistance indication to the patient-staff communications system. When a Peripheral Station is activated, visual indication of the call displays at the dome light associated with the patient room, and an appropriate call indication registers on the staff console, as well as on any installed and covering annunciators.
- B. Each room shall be capable of supporting more than nine Peripheral Stations. These stations shall be configurable to generate any level of call supported by the system configuration. Examples of Peripheral Stations are: Lavatory, Shower, Staff Emergency, Remote Cancel, Housekeeping, Code Blue, Code Pink, Urgent, Family Call, Staff Normal, Manual Presence, Auxiliary Inputs, etc.
- C. Pushbutton/Pull Cord Stations shall be field configurable to allow one, two, or three pushbuttons, with or without a pull cord.
- D. Call type/priority for each pushbutton or pull cord shall be programmable in system programming to annunciate the Owner-determined call type. The physical device button label shall be replaceable to match the specified call type/priority.
- E. Peripheral Stations shall provide on-board lighting for visibility in dark rooms.
- F. Peripheral Stations shall require only two wires for installation.
- G. Peripheral Stations shall support the reuse of existing wiring.
- H. Each Peripheral Station button shall have a dedicated LED to indicate that the button has been pressed or is actively indicating a call.
- I. All Peripheral Stations shall have the ability to be individually numbered to represent a separate and distinct location, even stations that are in the same daisy chain.
- J. Peripheral Stations shall not require any screws to be removed for maintenance personnel to remove the station.
- K. Peripheral Stations shall NOT have DIP switches that require manual setting by field personnel. Each station shall have a preconfigured identification number that specifies the station type automatically. Stations utilizing DIP switches shall not be considered.

- L. Peripheral Stations shall be hot swappable and not require system shutdown or removal of power prior to replacement.
- M. Peripheral Station pull cords shall be made of a non-contaminant material to reduce the spread of nosocomial infections. Pull cords made of cotton or other absorbent materials will not be accepted.
- N. Peripheral Stations shall provide a cleaning mode to allow housekeeping to clean station surfaces without generating false calls. Activating cleaning mode shall temporarily disable front panel buttons for a configurable period of time.
- O. All Peripheral Stations must be fully supervised.

2.16 CORRIDOR DOME LIGHTS

- A. Corridor (dome) and zone lights provide bright, easy-to-see visual annunciation that speeds response time and increases caregiver efficiency. These devices are typically installed in corridors and outside patient rooms to provide staff with a visual cue as to the origin of a call placed on the system.
- B. Corridor (dome) lights operate in a similar fashion to annunciator panels or staff consoles: the light color and flash rate indicates the type and priority of the call. Models are available with one, two, or four sections.
- C. Each Corridor Light shall utilize Light Emitting Diodes (LED) for displaying colors. Corridor Lights utilizing incandescent bulbs shall not be accepted.
- D. Corridor and Zone Lights shall be available in one, two, or four sections.
- E. To maintain aesthetics, reduce obstruction, and limit risk of damage to devices, the maximum size of each Corridor Light shall not be greater than 5 inches in length, nor shall it protrude more than 3.5" from the mounted surface.
- F. Each Corridor Light section shall be capable of indicating in excess of eight Owner-selected configurable colors. Corridor Lights requiring more than four sections to provide this many colors shall not be acceptable.
- G. To allow for maximum flexibility, the Corridor Light shall be configurable via programming to allow multiple sections of a single light to illuminate and/or flash the same color for higher priority calls.
- H. Corridor Lights shall be able to match most existing Corridor Light schemes via programming. Systems with corridor light schemes that are not able to match existing systems will not be accepted.
- I. Any corridor lights requiring the replacement of filter caps or lenses to obtain facility-requested corridor light colors for any priority shall not be accepted.
- J. Corridor Light shall provide a diagnostic indication of room status to prevent maintenance personnel from disrupting patients.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with the NEC and UL listed for medical electrical equipment.
- B. Locate equipment in accordance with contract drawings and manufacturer requirements.
- C. General
 - 1. All equipment shall be attached to walls and ceiling/floor assemblies and shall be mounted firmly in place. Fasteners and supports shall be sized to support the required load.
- D. Conductors
 - 1. The requirements of this section apply to all system conductors, DC power, and grounding/shield drain circuits, and to any other wiring installed by the Contractor pursuant to the requirements of these specifications.
 - 2. All circuits shall be rated and power limited in accordance with the National Electric Code (NEC), and installed in conduit or enclosed raceway. All System conductors shall be of the type(s) specified herein.
 - a. Category 5/5E or Category 6
 - b. 16 AWG Power
- E. Conductors and Raceways
 - 1. The entire System shall be installed in a skillful manner in accordance with approved Manufacturer's installation manuals, shop drawings, and wiring diagrams. The Contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for the complete installation. All wiring shall be of the type required by the NEC and approved for the purpose by local authorities having jurisdiction.
 - 2. Any shorts, opens, or grounds found on new or existing wiring shall be corrected prior to the connection of these wires to any panel component or field device.
 - 3. All penetration of floor slabs and firewalls shall be fire-stopped in accordance with all local fire codes.

3.2 FIELD QUALITY CONTROL

- A. Test & Inspection
 - 1. All wiring shall be tested for continuity, shorts, and grounds before the System is activated.
 - 2. All CAT5e or CAT6 cable shall have a performance test performed to verify proper operation and test results provided to Nurse Call Technician prior to startup.
 - 3. All test equipment, instruments, tools, and labor required to conduct the tests shall be made available by the installing Contractor.

4. The System, including all its sequence of operations, shall be demonstrated to the Owner or his Representative. In the event the System does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his Representatives, and the Fire Inspector.
5. At the final test and inspection, a factory-trained Representative of the System Manufacturer shall demonstrate that the System functions properly in accordance with these specifications. The Representative shall provide technical supervision, and shall participate during all of the testing for the System.

3.3 WARRANTY

- A. The Contractor shall warranty all materials, installation, and workmanship for one (1) year from date of acceptance, unless otherwise specified. A copy of the Manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals.
- B. The System Supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation. Any defects that render the System inoperative shall be repaired within 24 hours of the Owner notifying the Contractor.

3.4 TRAINING

- A. The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building Owner, detailing the proper operation of the installed System.
- B. The instruction shall be presented in an organized and professional manner by a person who has been factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

END OF SECTION 275223

SECTION 28 00 00 - GENERAL ELECTRONIC SAFETY AND SECURITY PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Scope of Work.
 - 2. Intent of Drawings.
 - 3. Pre-Bid Site Visit.
 - 4. Definitions.
 - 5. General Standards of Materials.
 - 6. Products and Substitutions.
 - 7. Applicable Codes.
 - 8. Guarantees and Certificates.
 - 9. Quiet Operation and Vibration Control.
 - 10. Temporary Shutdown of Existing Systems.
 - 11. Coordination.
 - 12. Shop Drawings, Product Data, and Samples.
 - 13. Owner Instruction.

1.3 SCOPE OF WORK

- A. The scope of the work included under Division 28 of the specifications shall include complete systems as shown in the Contract Documents and specified herein. Any work reasonably inferable or required to result in a complete installation or the intended operation and performance of the systems, shall be included in the Base Bid except where there is specific reference to exclusion and incorporation in other quotations.
- B. A brief written Scope of Work appears in Division 01.

1.4 INTENT OF DRAWINGS

- A. Provide complete and functional systems for the project. The systems shall conform to the details stated in the specifications and shown on the drawings. Items or work not shown or specified, but required for complete systems, shall be provided and conform with accepted trade practices. The drawings and specifications are presented to define specific system requirements and serve to expand on the primary contract requirements of providing complete systems. The drawings are diagrammatic and indicate the general arrangement and routing of the systems included in this contractors work.

- B. Do not scale the drawings. Because of the scale of the drawings, it is not possible to indicate offsets, fittings, valves, or similar items which may be required to provide complete operating systems. Carefully investigate conditions affecting the work associated with this project. Check and verify dimensions and existing conditions at the site. Install systems in such a manner that interferences between pipes, conduit, ducts, equipment, architectural and structural features are avoided. Provide items required to meet the project conditions without additional cost to the owner.
- C. These documents may not explicitly disclose final details required for a complete systems installation; however, contractors shall possess the expertise to include the necessary appointments of complete operating systems.
- D. Contractors shall be "Experienced" (as defined in Division 01) in this type of construction and realize the extent of the work required.

1.5 PRE-BID SITE VISIT

- A. Bidders shall visit the site and become completely familiar with existing conditions prior to submitting their bid. No extra charges shall be allowed as a result of existing conditions.

1.6 DEFINITIONS

- A. Specific terminology, as used herein, shall have the following meanings:
 - 1. "Furnish"...Supply and deliver to project site, ready for unloading, unpacking, assembly,
 - 2. "Finished Space" ...Space other than mechanical rooms, electrical rooms, furred spaces, pipe chases, unheated spaces immediately below roof, space above ceilings, unexcavated spaces, crawl spaces, tunnels, and interstitial spaces.
 - 3. "Conditioned"...Spaces directly provided with heating and cooling.
 - 4. "Unconditioned"...Spaces without heating or cooling including ceiling plenums.
 - 5. "Indoors"...Located inside the exterior walls and roof of the building.
 - 6. "Outdoors"...Located outside the exterior walls and roof of the building.

1.7 GENERAL STANDARDS OF MATERIALS

- A. Equipment and materials, unless otherwise noted, shall be new and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products for a period of not less than five years.
- B. Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical, including equipment, assemblies, parts and components.
- C. Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified or listed by such organizations.

Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.

- D. With respect to custom made equipment or related installations which are constructed specially for this project, the manufacturer shall certify the safety of same on the basis of test data. The Owner shall be furnished copies of such certificates.

1.8 PRODUCTS AND SUBSTITUTIONS

- A. Where a specific manufacturer's product is specified, the Contract Amount shall be based on that product only. Refer to Division 01 for requirements.
- B. Where several manufacturer's products are specified, the Contract Amount shall be based upon the specified products only. Refer to Division 01 for requirements.

1.9 APPLICABLE CODES

- A. Materials furnished and work installed shall comply with applicable codes listed in Division 01, with the requirements of the local utility companies, and with the requirements of governmental departments or authorities having jurisdiction.

1.10 GUARANTEES AND CERTIFICATES

- A. Defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract resulting from same, shall be replaced or repaired at no extra cost to the Owner for the duration of the stipulated guarantee periods.
 - 1. Unless specifically indicated otherwise, the duration of the guarantee period shall be one (1) year following the date of Substantial Completion. Temporary operation of the equipment for temporary conditioning, testing, etc., prior to occupancy will not be considered part of the warranty period.

1.11 TEMPORARY SHUTDOWN OF EXISTING SYSTEMS

- A. Plan installation of new work and connections to existing work to insure minimum interference with regular operation of existing systems. Some temporary shutdown of existing systems may be required to complete the work.
- B. Submit to the Owner in writing for approval, proposed date schedule, time, and duration of necessary temporary shutdowns of existing systems. Submit schedule at least fifteen (15) calendar days in advance of intended shutdown. Shutdowns shall be made at such times as shall not interfere with regular operation of existing facilities and only after written approval of Owner. The Owner reserves the right to cancel shutdowns at any time prior to the shutdowns. To insure continuous operation, make necessary temporary connections between new and existing work. Bear costs resulting from temporary shutdowns and temporary connections. No additional charges shall be allowed for Owner-canceled shutdowns that must be rescheduled.
- C. Shutdowns must be performed by the Owner. Do not shut-down any system. The Owner reserves the right to require a walk-through of any shutdown prior to the

shutdown. Following electrical shutdowns, verify that affected motors are rotating in the proper direction. Bear costs associated with reverse rotated motors.

1.12 COORDINATION

- A. Coordinate and furnish in writing to the Architect information necessary to permit the work to be installed satisfactorily and with the least possible interference or delay.
- B. Coordination drawings shall be prepared as defined in Division 01. No installation of permanent systems shall proceed until the coordination drawings are reviewed by the Architect. No extra charges shall be allowed for changes required to accommodate installation of systems provided under other divisions of this contract.
- C. Coordination drawings shall be developed from individual system shop drawings and contractor fabrication drawings. Electronic or other reproduced engineering design drawings used as coordination drawings are not acceptable.
- D. When work is installed without proper coordination, changes to this work deemed necessary by the Architect shall be made to correct the conditions without extra cost to the Owner.
- E. The value of the coordination drawings shall be identified as a line item in the Schedule of Values. If the coordination drawings are not submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of coordination drawings shall be a minimum of two (2.0) percent of this Contract Amount.

1.13 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- A. Shop drawings, product data, and samples shall be submitted in accordance with the provisions of Division 01.
- B. The following shall be submitted by the Contractor for review:
 - 1. Scale shop drawings showing system components with sizing indicated, including but not limited to:
 - a. equipment locations.
 - b. raceways
 - c. insert and sleeve locations
 - d. hangers, anchors and guides
 - e. expansion joints
 - f. access doors
 - 2. Product data for system components and materials (including construction standards).
 - 3. Samples of finishes and trim exposed to view, such as fixture trim, escutcheon plates and similar items.
- C. The value of shop drawings, product data and samples shall be identified as a line item in the Schedule of Values. If the shop drawings, product data and samples are not

submitted as required, their value shall be credited to Owner in accordance with the provisions of Article 7 of the General Conditions. The value of these items shall be a minimum of one (1.0) percent of this Contract Amount.

1.14 OWNER INSTRUCTION

- A. After final tests and adjustments have been completed, furnish the services of qualified personnel to instruct representatives of the Owner in the operation and maintenance procedures for equipment and systems installed as part of this project. Operation and maintenance instructions for major items of equipment shall be directly supervised by the equipment manufacturer's representative. Supply qualified personnel to operate equipment for sufficient length of time as required to meet governing authorities' operation and performance tests and as required to assure that the Owner's representatives are properly qualified to take over operation and maintenance procedures. Minimum instruction period shall be 24 man hours. The instruction period shall be broken into segments at the discretion of the Owner.
1. Notify the Architect, the Owner's representative and equipment manufacturers' representatives, by letter, as to the time and date of operating and maintenance instruction periods approved by the Owner at least one (1) week prior to conducting same.
 2. Forward to the Architect the signatures of all those present for the instruction periods.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 28 00 00

SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Project Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Electronic safety and security equipment coordination and installation.
 - 2. Common electronic safety and security installation requirements.
 - 3. Excavating and backfilling.
 - 4. Demolition
 - 5. Waterproofing.
 - 6. Weatherproofing locations.
 - 7. Cutting and Patching.
 - 8. Painting.
 - 9. Equipment Foundations, Supports, Piers and Attachments.
 - 10. Equipment Guards and Rails.
 - 11. Cleaning, Protecting and Adjusting.
 - 12. Welding.
 - 13. Sleeves for raceways and cables.
 - 14. Sleeve seals.
 - 15. Grout.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. Wiring: Cable and/or wire installed in Raceway.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 DEMOLITION

- A. Review the construction documents, to determine the affected areas of the existing structure. Remove electronic safety and security appurtenances in the affected areas not to be reused including wire, conduit, switches, outlets, and fittings.
- B. Schedule and coordinate demolition with the Owner.
- C. Any conduit or wiring that is not to be permanently removed or that feeds other remaining sections of the building shall be relocated as necessary and rerouted and reconnected as required.
- D. Items removed above shall become the property of the Owner unless otherwise noted. If the Owner has no use for any of the items, remove them from the site.
- E. The Owner has the right-of-first-refusal for any items to be demolished, salvaged or removed. The Contractor and Owner shall jointly review the space where demolition is to occur and identify items the Owner elects to retain prior to demolition and removal. Remove items to be retained by the Owner and deliver them to the location directed by the Owner within a (5) five mile radius of the project. Promptly remove and properly dispose of materials, equipment, debris, etc., which is not specified for reuse, storage, or retainage by Owner.
- F. Maintain the continuity of any present electronic safety and security circuits that may be interrupted by these alterations even though they may not be indicated on the drawings. Furnish the labor and necessary materials required to restore the electronic safety and security circuit.
- G. Where electronic safety and security circuits are looped and outlets are removed, make adjustments and connections to restore the circuits.
- H. Where existing electronic safety and security devices and items are to be removed, ceilings, floors, wall partitions, etc., are to be patched by the Electronic safety and security Contractor. Particular attention must be paid to associated construction types and methods of affected areas. All patching for these areas is to match the existing and intended finishes for that area no matter what the type of construction. Coordinate all patching work fully with the Architect and General Contractor. Blank cover plates over demolished items will not be acceptable.
- I. Provide cutting and patching to match existing finish of roof, wall, floor, etc., required for demolition of existing systems. Fire and smoke ratings compromised due to demolition shall be immediately restored. Repair or apply fire proofing to structural components that are exposed due to demolition, unless noted otherwise.

1.6 WATERPROOFING

- A. Where work pierces waterproofing, including waterproof concrete, the method of installation shall be approved by the Architect prior to performing the work. Furnish necessary sleeves, caulking and flashing required to make openings absolutely watertight.

1.7 WEATHERPROOFING LOCATIONS (WP)

- A. Communication apparatus, such as outlet boxes, switches, connection panels, speakers, cameras, and other devices shall be weatherproof gasketed type, NEMA Types 3 or 4 in the following instances:
 - 1. On surface of exterior face of building, including areas where not under canopies, cast boxes with threaded hubs must be used and under canopies steel boxes with gasket connections to devices.
 - 2. In any areas where specifically noted "WP" or required by the NEC or Regulations mentioned herein.
 - 3. Within air conditioning enclosures.
 - 4. In underground splice boxes.
 - 5. On building roof.
 - 6. In unconditioned spaces subject to exterior ambient conditions such as loading docks and parking garages.

1.8 CUTTING AND PATCHING

- A. Provide cutting and patching necessary to install the work specified herein. Patching shall match adjacent surfaces. Refer to Division 01, Cutting and Patching for specific directions.
- B. No structural members shall be cut without prior approval of the Architect; such cutting shall be done in a manner directed by him.
- C. Provide ceiling removal and replacement where work above ceilings is required. Replace ceiling components damaged in the process.
- D. Provide patching where electronic safety and security devices are removed from walls, ceilings or floors.

1.9 ACCESSIBILITY

- A. Coordinate to ensure the sufficiency of the size of shafts, and chases, and the adequacy of clearances in hung ceilings and other areas required for the proper installation of this work.
- B. Locate equipment which must be serviced, operated or maintained in fully accessible positions. Locations in ceilings requiring access shall be coordinated with, but not limited to lights and speakers. Equipment requiring access shall include, but is not necessarily limited to, motors, junction boxes, fire dampers, controllers, switchgear, etc.
- C. Indicate the locations of access doors for each concealed device, concealed behind finished construction and requiring service on the coordination drawings. Equipment below floor slab or finished grade shall also be indicated on the coordination drawings.

- D. Furnish access doors under this division for installation by General Contractor. Coordinate during bidding phase with General Contractor. Locations of access doors in finished construction shall be submitted in sufficient time to be installed in the normal course of the work.
1. Manufacturers: Subject to compliance with requirements, furnish access doors by one of the following:
 - a. Bar-Co., Inc.
 - b. J. L. Industries
 - c. Karp Associates, Inc.
 - d. Nystrom, Inc.
 2. Materials and Fabrication:
 - a. General: Furnish each access door assembly manufactured as an integral unit, complete with all parts and ready for installation.
 - b. Steel Access Doors and Frames: Fabricate units of continuous welded steel construction, unless otherwise indicated. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of support shown.
 - c. Frames: Fabricate from 16-gauge steel.
 - 1) Fabricate frame with exposed flange nominal 1 inch wide around perimeter of frame for units installed in the following construction:
 - a) Exposed Masonry
 - 2) For gypsum drywall or veneer gypsum plaster, furnish perforated frames with drywall bead.
 - 3) For installation in masonry construction, furnish frames with adjustable metal masonry anchors.
 - 4) For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
 - d. Flush Panel Doors: Fabricate from not less than 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175°. Finish with manufacturer's factory-applied prime paint.
 - 1) For fire-rated units, provide manufacturer's standard insulated flush panel/doors, with continuous piano hinge and self-closing mechanism.
 - e. Locking Devices: Furnish flush, screwdriver-operated cam locks of number required to hold door in flush, smooth plane when closed.

1.10 PAINTING

- A. Painting requirements of this section shall conform to Division 9 Specification Sections for Painting.
- B. Provide surface preparation, priming, and final coat application in strict accordance with manufacturer's recommendations.
- C. Electrical motors, pump casings and other similar items shall be provided with three (3) coats of machinery enamel at the factory, and shall be carefully cleaned, rubbed down and oiled after installation.
- D. Provide prime coat painting for the following:
 - 1. Indoor miscellaneous steel and iron provided under this Division of the specifications.
 - 2. Indoor hangers and supports provided under this Division of the specifications.

1.11 EQUIPMENT FOUNDATIONS, SUPPORTS, PIERS AND ATTACHMENTS

- A. Provide necessary foundations, auxiliary steel, supports, pads, bases and piers required for equipment specified in this division; submit drawings in accordance with Shop Drawing Submittal requirements prior to the purchase, fabrication or construction of same.
- B. Construction of foundations, supports, and pads where mounted on the floor, shall be of the same materials and same quality of finish as the adjacent and surrounding floor material.
- C. Equipment shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect, not strong enough shall be replaced as directed, with no additional cost to the Owner.

1.12 CLEANING, PROTECTING AND ADJUSTING

- A. Cleaning
 - 1. General cleaning requirements are specified in Division 1.
 - 2. Upon completion of the work, clean the exterior surface of equipment, accessories, and trim installed. Clean, polish, and leave equipment, accessories, and trim in first-class condition.
- B. Protection of Surfaces
 - 1. Protect new and existing surfaces from damage during the construction period.
 - 2. Provide plywood or similar material under equipment or materials stored on floors or roofs. Provide protection in areas where construction may damage surfaces.

3. Surfaces damaged during the construction shall be repaired or replaced at the cost of the Contractor at fault. The method of repairing or replacing the surface shall be approved by the Owner and Architect.

C. Protection of Services

1. Protect new and existing services from damage during the construction period.
2. Repair, replace, and maintain in service any new or existing utilities, facilities, or services (underground, overground, interior, or exterior) damaged, broken, or otherwise rendered inoperative during the course of construction.
3. Services damaged during the construction shall be replaced at the cost of the Contractor at fault. The method used in repairing, replacing, or maintain the services shall be approved by the Owner and Architect.

D. Protection of Equipment and Materials

1. Equipment and materials shall be stored in a manner that shall maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
2. Equipment and material, if left unprotected and damaged, shall be repainted or otherwise refurbished at the discretion of the Owner. Equipment and material is subject to rejection and replacement if, in the opinion of the Architect or the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use or performance is questionable, or that its normal life expectancy has been curtailed.
3. During the construction period, protect equipment from damage and dirt.

E. Adjusting

1. After the entire installation has been completed, make required adjustments to until performance requirements are met.

1.13 SPECIAL TOOLS

- A. Provide the Owner's representative with two (2) sets of special tools required for operation and maintenance of equipment provided.

1.14 WELDING

A. General Requirements

1. This paragraph covers the welding of systems. Deviations from applicable codes, approved procedures and approved shop drawings shall not be permitted. Materials or components with welds made off the site shall not be accepted if the welding does not conform to the requirements of this specification. Develop and qualify procedures for welding metals included in the work. Certification testing shall be performed by an approved independent testing laboratory. Bear costs of such testing.

2. Certified welders, previously certified by test, may be accepted for the work without re-certification provided that all of the following conditions are fulfilled:
 - a. Submit copies of welder certification test records in accordance with this Division and Division 01 requirements.
 - b. Testing was performed by an independent testing laboratory.
 - c. The welding procedures and welders are certified in accordance with the "ASME Boiler and Pressure Vessel Code," and base materials, filler materials, electrodes, equipment, and processes conform to the applicable requirements of this specification.
 - d. Certification has been within a one (1) year period from the start of the project.
3. Filler metals, electrodes, fluxes and other welding materials shall be delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to assure safe handling.
4. Submit welding certificates for review. Each welder assigned to work covered by this specification shall be certified by performance tests using equipment, positions, procedures, base metals, and electrodes or bare filler wires.
5. Before assigning welders to the work, provide the architect with their names, together with certification that each individual is certified as specified. No welding work shall start prior to submissions. The certification shall state the type of welding and positions for which each is certified, the code and procedure under which each is certified, date certified, and the firm and individual certifying the certified tests.
6. Each welder shall be assigned an identifying number, letter, or symbol that shall be used to identify his welds. A list of the welders' names and symbol for each shall be submitted. To identify welds, either written records indicating the location of welds made by each welder shall be submitted, or each welder shall apply his mark adjacent to his weld using an approved rubber stamp or felt-tipped marker with permanent, weatherproof ink or other approved methods that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers shall be confined to the weld reinforcing crown, preferably in the finished crater.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Coordinate piping systems installed at a required slope.
- F. Apply for detailed and specific information regarding the location of equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of failure to obtain this information shall be relocated and re-installed without additional expense to the Owner. Determine the actual direction of door swings, so that local switches and other controls shall be installed at the lockside of doors, unless otherwise noted. Improperly located switches shall be relocated without additional expense to the Owner.
- G. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of outlets or equipment without written consent of the Architect and Owner.
- H. Unless otherwise mentioned or indicated, mounting heights of outlets are shown on the drawings or in the specification. Dimensions given shall be considered to be from center of outlet to finished floor.
- I. Coordinate the location and elevation of all electronic safety and security devices and fixtures with the architectural interior elevation plan and reflective ceiling plan prior to installation.
- J. Properly rough in for the electronic safety and security raceways and equipment under this contract and modify as required for coordination during the construction period.
- K. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- L. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 01 Section "Access Doors and Frames."

- M. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 01 Section "Penetration Firestopping."

3.2 WELDING

- A. Perform welding in accordance with qualified procedures using certified welders. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. Welding of hangers, supports, and plates to structural members shall conform to AWS specifications.
- B. Field bevels and shop bevels shall be by mechanical means or by flame cutting. Where beveling is by flame cutting, thoroughly clean surfaces of scale and oxidation just prior to welding. Beveling shall conform to ANSI B31.1 and AWS B3.0.
- C. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening shall not be permitted. Welders responsible for defective welds must be re-certified.
- D. Store electrodes in a dry heated area, keep free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

3.3 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

- A. Electronic safety and security penetrations occur when raceways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, fire-rated floor, or wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 01 Section "Joint Sealants."
- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 01 Section "Penetration Firestopping."
- J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in "Penetration Firestopping" Specification Sections.

3.6 DUST, DIRT AND NOISE

- A. Carry out new work and make changes, relocations, and installations with a minimum of noise. Site areas and new equipment, floors and walls, shall be adequately protected from dust and dirt caused by the work. Protection shall include suitable temporary barriers or coverings. The exterior and interior premises of each building shall be kept clean as possible during construction. Damages to surfaces or equipment as a result of negligence shall be replaced or corrected as required.

3.7 ENVIRONMENTAL AIR PLENUMS

- A. In spaces over hung ceiling which are used for environmental air handling purposes as defined by Article 300.22C of the National Electric Code, power data and electronic safety and security cable must be in conduit or of the type cable rated for air plenum use. Cable type and/or raceway is generally indicated on the drawings and specifications although the Contractor shall be responsible to clearly define ceiling space used for environmental air purposes.

3.8 SPECIAL ENGINEERING SERVICES

- A. In the instance of complex or specialized systems that are included in Division 28; the installation, final connections, and testing of such systems shall be made under the direct supervision of competent authorized service engineers who shall be in the employ of the respective equipment manufacturer. Provide the Owner with copies of instruction manuals and booklets for each system and piece of equipment installed. Provide any additional instruction to the Owner over and above the listed above in the care, adjustment, and operation of all parts of the electronic safety and security systems.

END OF SECTION 28 05 00

SECTION 283111 – DIGITAL ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF DEMOLITION

- A. Remove existing fire alarm in area of renovation, including initiating devices, annunciating devices and all associated wiring as shown and or described on the drawings.
- B. Relocated and provide new devices as indicated on plans and required for renovation.
- C. Provide all required reprogramming of existing fire alarm panel.

1.2 NEW WORK

- A. Provide input and output alarm devices and all associated control panels, wiring and components. In addition, provide outputs from the new fire alarm panel for transmission of an alarm and supervisory signal to a remote Central Station. Coordinate this work with the Owner.
- B. Provide all required reprogramming of existing fire alarm panel.

1.3 SUBMITTALS

- A. Shop Drawings and Product Data - Prior to installation, submit and obtain approval from the City of Philadelphia, Department of Licenses and Inspections, the Owner's Insurance Carrier and the Design Professional for use and installation within this project. Any work installed prior to obtaining these approvals shall be subject to rejection and or rework or replacement as required at no additional cost to the Owner
- B. After approval by the aforementioned agencies, submit one complete record set of documents bearing the approval of the aforementioned agencies to the Owner.
- C. All shop drawing submittals are to be complete, partial submissions shall not be accepted. At a minimum, the following data shall be required for the shop drawing submission.
 - 1. Floor plans indicating name and use of each room.
 - 2. Details of ceiling heights and construction.
 - 3. Locations of all alarm-initiating and notification appliances.

4. All conductor types and sizes.
 5. Complete system battery calculations indicating the impact on the system of the new devices.
 6. System voltage drop calculations.
 7. Manufacturers model numbers and listing information for equipment, devices and materials.
 8. Mounting heights of all accessible system components.
- D. Provide, in "Plain English", description for each alarm, trouble and supervisory output signal. The Plain English" descriptions shall include locations, room designations, or similar descriptors and point of compass designations un-coded. Review all descriptions with and obtain the approval of the Owner prior to shop drawing submission.
- E. The use of code numbers, zone numbers or abbreviated text shall not be acceptable. Any submission of coded, zoned or abbreviated text shall be rejected at the time of shop drawing submission without cause or comment.
- F. Provide all manufacturers' catalog cuts for each piece of equipment, all devices and components required for the system.
- G. The contractor shall, attached to the shop drawing and equipment data sheet submittal provide a written, narrative, description of the fire alarm and detection system, proposed design and arrangement. The narrative shall describe the system type and specific features of the proposed equipment. The narrative shall include an exact English description of all signaling arrangements, detection arrangements, output and supervisory functions.
- H. Upon completion of the project provide a composite as-built drawing in AutoCAD 2000 or later, on 3½-inch CD-Rom to the Owner. The Owner shall own all magnetic media and original drawings addressed under this section. The Owner shall have the right to modify, reproduce, distribute and use the magnetic media and original drawings in any fashion or for any use that they may desire. The contractor and the manufacturer shall retain a copy of all as-built drawings and documents. The contractor and the manufacturer shall not have the right to use any magnetic media, drawings, documentation or other material describing or relating to the fire alarm system without the expressed written permission of the Owner.

- I. The contractor shall be required to submit the following series of as-built drawings at not less than 1/8-inch scale:
 - 1. Floor Plans - Actual "As-Built" Installation Drawings, Not Shop Drawings.
 - 2. Schematics of all auxiliary devices and auxiliary system connections such as HVAC, etc.
- J. Copies and all necessary explanatory documentation, as may be required by the Owner, of all software and programming used in the fire alarm system shall be provided to the Owner at the time of acceptance testing.

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of the following Regulatory Codes:
 - 1. International Building Code – 2018.
- B. Comply with the requirements of the following Standards:
 - 1. NFPA 70-2017 National Electrical Code.
 - 2. NFPA 72-2016: National Fire Alarm Code.
- C. FM Approval Guide 2012.
- D. UL Fire Protection Equipment List 2012.

1.5 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall have a minimum of five years of documented experience in the design and installation of the actual type of system and devices being installed.
- B. The Contractor shall assign to the project a staff member, certified NICET Level III for fire alarm systems. This person shall have a minimum of five years of documented experience in the design and installation of NFPA compliant fire alarm systems.

- C. The Contractor shall assign the NICET Level III certified person to supervise the preparation of all technical documents, drawings, installation, testing and acceptance testing as required by this specification. The NICET Level III certified person shall be present at all shop drawing review meetings, design issue meetings and all acceptance tests. All drawings shall include the NICET Level III person's name and license number. In lieu of a NICET Level III person, the Contractor may substitute a State of Pennsylvania licensed professional engineer who specializes in fire protection, electrical engineering or electronic engineering, and who meets all other experiential criteria defined in this section. Additionally the contractor shall be licensed by the City of Philadelphia.
- D. The equipment manufacturer shall be a company specializing in NFPA 72 fire alarm and detection systems with a minimum of ten years documented experience.
- E. All qualification documents required herein shall be submitted with the Contractors bid and also at the time of shop drawing submittal. Failure to submit substantiated qualifications may render the bid as not responsive and unacceptable.

1.6 UNIT PRICES

- A. Provide individual unit prices for add and deduct values for each fire alarm system component, including all input and output devices, panels, batteries and wiring. For individual devices assume a minimum of ten feet (10') of approved wiring and terminations, back box and installation.
- B. Unit prices shall be effective for a period of not less than four years from the time of final system acceptance. The fire alarm vendor shall be permitted to include an inflation percentage to their unit pricing. This inflation factor shall be described in the bids.
- C. Failure to submit specific unit prices in the bib may result in the bid being rejected.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All products specified in Part 2 shall be UL listed and FM Approved for computer based, addressable fire alarm systems.

2.2 EQUIPMENT

- A. Addressable Analog Smoke Detectors

1. Provide addressable, analog smoke detectors where shown on the drawings. Detectors shall have alarm verification and environmental compensation features. Such features shall be reviewed with and approved by the Owner.
2. Provide each detector with a built-in test device.
3. Provide smoke detector head and twist-lock base with vandal-resistant security lock.
4. Provide smoke detectors with flashing status-indicating LED for visual supervision. When the detector is actuated, the LED shall stop flashing and display a steady light at full brilliance. The detector shall be resettable by actuating the control unit reset command.

B. Strobe Lights - Wall Mounted

1. Provide Xenon strobe lamp assemblies each with minimum light candela (cd) ratings as shown on the drawings. In the event that the strobe intensity shown on the drawings is not available from the selected manufacturer the next higher strobe rating available shall be used. The use of 15/75 cd strobes shall be acceptable as an alternate for 15 cd strobes only.
2. Each unit shall have two wires in and two wires out. The strobe lamps shall operate at a current of 24V DC. The strobe lens housings shall be engraved or stenciled with word "FIRE". The lens shall be pyramidal shaped and clear or nominal white, unfiltered or clear filtered white light.
3. All strobe circuits shall be synchronized.

C. Combination Alarm Speaker And Strobe Lights - Ceiling Mounted

2.3 SUPERVISORY REQUIREMENTS

- A. All components within the fire alarm system shall be continuously electrically supervised.

2.4 EMERGENCY POWER REQUIREMENTS

- A. The system in its entirety shall be provided with a normal building power supply.
- B. In addition the system, in its entirety, shall be provided with integral battery back-up with the capability of supporting the system for a period of not less than 24 hours plus a minimum of a full 10 minutes of alarm at the end of the 24-hour period in the event of a failure of normal electric service.

- C. The transfer from normal power to battery backup shall be automatic, causing an annunciation indicating normal power failure.
- D. Upon the restoration of normal power, the transfer shall again be automatic, silencing normal power failure indicator.

2.5 SYSTEM OPERATION

- A. The actuation of any automatic or manual fire alarm input device (manual station or sprinkler waterflow) shall activate a fire alarm signal, audible and visual, throughout all areas.

2.6 WIRING AND CONDUIT

- A. The contractor shall provide wiring in accordance with the requirements of NFPA 70 and 72.
- B. The installation of exposed conduit shall be minimized. The contractor shall obtain the approval of the Owner and the Design Professional prior to installing any exposed conduit in the building.
- C. Size and quantity of data, communication and control wiring, along with related conduit where required, shall be in accordance with this specification, the manufacturer's recommendations, and the referenced Codes, Standards, Regulations and other Specification Sections within this Division.
- D. Fire alarm power and branch circuits shall be wired in accordance with NFPA 70 and 72. Each power source shall breaker shall be marked "FIRE ALARM POWER SOURCE" and be provided with a "red" locking device so as to prevent accidental disconnection. Contractor shall be responsible to run all power to the fire alarm system.
- E. Initiating and signal circuits including any and all non-power limited fire protective signaling cable, shall consist of solid only copper conductor, 150 volt, insulation rated 60 degrees C. Any and all power limited fire protective signaling cable shall consist of copper conductor, 300 volts, insulation rated 105 degrees C. Power limited fire protective cable classified for fire and smoke characteristics, shall consist of solid only, 300 volt, insulation rated 105 degrees C, suitable for use in air handling ducts, and hollow spaces used as ducts and plenums.

- F. Any fire alarm cable which is not required to be installed in conduit and is located in an air plenum space shall be of a type of cable and insulation which is approved by UL/FM for air plenums.
- G. Plenum rated cable shall be installed in conduit at the following locations:
- H. Within areas where physical damage is anticipated.
- I. Where connecting to wall mounted terminal devices, provide conduit stub-ups, or spiral wound armor jacketing.
- J. Conduit "sleeves" shall be installed where wiring passes through any wall and/or partition.
- K. Standard twisted/shielded pair wiring shall be run within conduit at all locations.
- L. Use 14 AWG minimum size twisted/shielded conductors for fire alarm signal circuit conductors. All communication bus cable shall be 18 AWG twisted/shielded solid copper wiring. Any wiring runs in areas within the building subject to moisture or the effects of weather, the contractor shall use water-resistant conduit, enclosures, fittings, and adapters.
- M. Specific attention shall be made to hanging methods, the use of bushings at junction box outlets and stub up outlets.
- N. Cables shall be run parallel to walls and/or partitions where ever possible, the cables shall be run through bridle rings which are to be properly affixed to the wall and/or partition at six foot intervals.
- O. Bridle rings shall support cables that run through ceiling areas. Where wiring drops below steel structure provide adequate supports to prevent strain. The cables shall not rest on top of the suspended ceiling assembly, nor shall they be bound to the sides of threaded rod without proper insulation from abrasion.
- P. Bridle rings shall be supported from the building structure and not from the ductwork, ceiling grid or ceiling grid wiring, pipes or pipe hangers or any other disciplines framing or supports.
- Q. Where two or more cables are run parallel to one another, and are not within bridle rings, they shall be bound together by nylon tie straps at six-foot intervals.

- R. All devices, boxes and conduit shall be installed plumb and level.
- S. Mount end-of-line device in a box with the last device or in a separate box adjacent to the last device in the circuit. Each end-of-line device box shall be labeled "EOL" and be visible from the front of the device. If "EOL" is mounted in a separate junction box, the face of the box shall be labeled.
- T. All detectors and other alarm devices shall be securely mounted with an approved back box. If visible, the back box shall either match the color of the device or the color of the wall surface if wall mounted.
- U. All system devices, panels, junction boxes and similar components shall be provided with a unique identifier number, which shall be:
 - 1. Labeled on each such device with a durable label capable of surviving environmental conditions.
 - 2. Labeled on all drawings.
 - 3. Labeled on all parts lists and required testing documentation.
- V. The Owner shall approve the unique identifier numbering system.
- W. Each conductor shall receive a unique and durable wire number at each terminal block, splice connection, device terminal and any other location where the conductor is landed. Each wire number shall be shown on the as-built drawings or a separate document shall be produced to describe the wiring to each device. In all areas where the atmosphere is unconditioned a clear, heat shrink protected sleeve shall protect the wire number.

2.7 MANUFACTURERS

- A. The following manufacturer's equipment is acceptable for use on this project, however, product data submission shall still be required as described in paragraph 1.2.
 - 1. Simplex Grinnel

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall be responsible for coordination efforts with other construction trades working within the scope of this project.

- B. Provide in accordance with the manufacturer's instruction all wiring, conduit and outlet boxes required for the installation of a complete and operable system.
- C. Strobe wiring shall be connected directly to the fire alarm control panel and not interfaced in any way with a standard intelligent circuit.

3.2 SITE TESTS

- A. The site tests shall be performed under the supervision of a factory trained representative of the equipment manufacturer. The tests shall be complete and follow the manufacturer's specifications. The testing shall be conducted in the presence of the Owner's representatives. A certified report shall be given to the Owner upon completion of the testing.
- B. Test shall consist of activation of each alarm-initiating device, visual confirmation of the activation of each strobe light, confirmation of the reporting of each alarm signal at the fire alarm control panel and at the remote annunciator panel and the performance of audibility tests to confirm code compliant audible levels.

3.3 TRAINING

- A. Provide to the Owner's select representatives formally scheduled training sessions, such that the select representatives are fully familiar with the system's configuration, software field changes, and minor trouble shooting capabilities.
- B. It shall be the responsible of the contractor to coordinate with the Owner, the number of representatives that will be trained and the location and the time required to complete these formalized training sessions.
- C. In addition, the operations of the completed system shall be thoroughly demonstrated to the Owner's satisfaction. At least two formally scheduled sessions shall be conducted to allow for all facility personnel to attend.

3.4 SYSTEM SOFTWARE

- A. Upon completion of this project, the contractor shall turn over to the Owner, the complete as-built fire alarm system program configuration. This information shall be in the following formats:
 - 1. Printed hard copy and,

2. Electronic media (CD-Rom).

- B. In addition, any revisions created during the warranty period shall also be issued to the Owner, at no additional cost, such that the Owner's copies of the programming are always up to date and complete.

3.5 MAINTENANCE MANUALS

- A. Maintenance manuals shall be furnished complete, each shall contain sufficient detailed information to enable the Owner's technicians to understand, operate and maintain the system equipment and to identify replaceable parts.
- B. The Maintenance Manuals shall contain the following sections.
1. General Description
 2. Operating Instructions
 3. Routine Maintenance

3.6 TROUBLE-SHOOTING

- A. Data, i.e. bill of materials, flow diagrams, single line diagrams, schematic diagrams, layouts, exploded views and spare parts list.
- B. MANUFACTURER'S STANDARD CATALOG CUTS ALONE SHALL NOT BE ACCEPTABLE.

3.7 GUARANTEE AND SERVICE

- A. Guarantee
1. The Contractor and equipment manufacturer shall guarantee all wiring and equipment for this system to be free of defects in workmanship and materials for a period of two-years from the date of final acceptance.

END OF SECTION 283111