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DIVISION 21 – FIRE SUPPRESSION

SECTION 21 05 00 - STANDARD CONDITIONS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 REFERENCE

- A. Requirements established within the portions of this project manual titled Division 1, General Requirements are collectively applicable to the work of this section.
- B. Instructions to Bidders, Special Conditions and addenda as issued are part of this specification.
- C. Plumbing/Fire Suppression drawings along with all other project drawings and specifications represent the work of this section.
- D. Drawings, Contract, General Conditions and Supplementary Conditions form a part of this section, by reference thereto and shall have the same force and effect as if printed herewith in full. Failure to review these sections shall not relieve the Contractor of his responsibility to fully comply with the terms therein.

1.02 SCOPE

- A. Provide labor, material, equipment, and supervision necessary to install complete operating fire suppression systems as indicated on the drawings and specified herein, including all work at the site and within the proposed construction areas to accomplish the required work.
- B. It shall be the contractor's responsibility to coordinate his work and the work of his subcontractors to ensure that all the work is covered. He shall designate who is responsible for various portions of work which may overlap so that there is complete coverage of all required work. It is the position of the owner and the A/E that all work is the responsibility of the mechanical contractor within this Division of the work.
- C. The fire suppression contractor shall remove the entire existing fire suppression system including valves, heads, piping, hangers, supports and related accessories.
- D. All work shown on the drawings and not expressly mentioned in the specifications and all work specified but not shown on the drawings, but necessary for the proper execution of same shall be performed by the contractor. It is not the intent of the drawings and specifications to describe every feature and detail of the work.
- E. No additions to the contract amount will be approved for any materials, equipment, or labor to perform additional work unless it can be clearly shown to be beyond the scope and intent of the drawings and specifications.
- F. It shall be the fire suppression contractor's responsibility to develop the design of the system based on current flow test results and to provide all the documentation necessary for final approval.
- G. Fire suppression contractor's scope of work shall include but not be limited to the following:
 - 1. Wet and Dry Sprinkler System, Siamese connection.
 - 2. Standpipe work.
 - 3. Demolition of existing work to accommodate new work.
 - 4. Modify existing systems affected by the new construction or alteration work. Patch and repair and finish to match existing.

- 5. Fire Pump, jockey pump, controller, and all associated fire pump work.
- 6. Refer to Commissioning of Systems Specification for additional work.

1.03 REGULATIONS, CODES, AND STANDARDS

- A. Work shall be performed in accordance with the latest adopted codes, amendments, regulations, and ordinances of the authorities having jurisdiction. Observe all safety regulations including the requirements of OSHA.
- B. Obtain and pay for all permits, connection charges, inspections, and certificates required to complete the work.
- C. Latest editions of any referenced standards shall govern.
- D. Contractor shall arrange and pay for all tests and inspections specified herein or required by above agencies and furnish required certificate of inspection to owner.
- E. Where the contract documents are more stringent but not in conflict with the applicable codes, the more stringent requirements shall be followed.

1.04 SUBMISSIONS

- A. The procedure for submissions of shop drawings shall be as specified in Division 1, or as a minimum, as indicated below.
- B. Furnish submissions of shop drawings and samples of materials and equipment as indicated in these sections, on the drawings, or as directed by the A/E. Submissions will be made in a timely fashion such that adequate time exists to review the drawings, or material, and arrive at the site in accordance with the project schedule.
- C. Submissions will not be accepted with work defined as "By Others". Identify contractor by name and with his approval so indicated. Submissions are required prior to purchasing, fabrication, or installation of any material or equipment. Submissions shall be reviewed and certified by the submitting contractor that they are in accordance with the project documents.
- D. When requested by the engineer, shop drawings shall be required to be submitted to designated agencies for review and approval prior to submission to the engineer.
- E. Contractor shall arrange and pay for all tests and inspections specified herein or required by above agencies and furnish required certificate of inspection to owner.
- F. Contractor to forward a copy of submittals which have electrical requirements to the Electrical Contractor (EC) for coordination of voltage, amperage, and phase. Response to be received from EC prior to ordering of equipment by mechanical contractor.
- G. Submissions shall include warranties by the manufacturer for equipment being provided. Submissions for commonly related items and equipment shall be combined in a single brochure with all items being furnished clearly identified.
- H. Shop drawings and submittals shall be checked and stamped by the contractor before submitting. They shall conform to measurements made at the site, the contract requirements, and coordinated with all other trades.
- I. Specific models in catalog sheets must be identified as well as all options, voltages, phases, etc. identified so as to be clear on what is being provided.
- J. Contractor and manufacturers shall be responsible for all physical characteristics of the equipment and field verify with final locations, coordinate with floor plans, confirm service access, clearances, confirm equipment arrangements, electrical disconnect clearances, and pathways/travel/access to the final equipment installation locations. Submission of equipment shop drawing will be deemed evidence of compliance with this requirement. If no shop drawing is submitted, contractor shall be fully responsible for a complete installation and assumes all related costs that affects the contractor and other trades.
- K. To aid in the preparation of submittals or shop drawings, the engineer can provide the

electronic files for use by the contractor. The electronic files will be provided upon execution of the engineer's electronic file release contract prepared specifically for this project. The electronic files will be released in the format used by the architect and engineer to design the project. If this file format is not compatible with the contractor's needs, additional charges for providing the changes to the requested file format may be necessary at \$175/hr billable to the contractor.

1.05 SITE INSPECTION

- A. Visit site, inspect, and become aware of all conditions which may affect the work. Investigate utilities, protection requirements for adjacent facilities, storage locations, and access to the construction area.
- B. Submission of bid will be deemed evidence of having complied with this request. Contractor may not request additional costs for existing conditions which were evident from inspection of the site.

1.06 SUBSTITUTIONS

- A. Material and equipment specified shall be deemed as that which the bidder's quotation represents.
- B. Once bids are accepted only that material and equipment listed in the specifications or added by addenda shall be acceptable. Substitution information for inclusion in an addenda must be received by the A/E at least 10 days prior to bid opening. If acceptable, an addenda will be issued which will add the additional acceptable manufacturers or materials and be available for all contractors to consider. A contractor cannot be the lowest bidder because he utilized substituted materials or equipment as opposed to specified materials or equipment.
- C. If the contractor submits alternate equipment, manufacturers, systems, methods, or materials, not specifically identified in the specifications, additional review and investigation time may be required by the engineer. If the engineer determines additional review time is required because of the substitution, then this will be a billable service by the engineer at the rate of \$175.00/hr. for such services. Also billable will be any redesign time and revisions to drawings should they be necessary for incorporation into the work. Services will be billable to the contractor making such substitutions and will be payable prior to approval or rejection.
- D. Contractor and manufacturers shall be responsible for all physical characteristics of the equipment and field verify with final locations, coordinate with floor plans, confirm service access, clearances, confirm equipment arrangements, electrical disconnect clearances, and pathways/travel/access to the final equipment installation locations. Submission of equipment shop drawing will be deemed evidence of compliance with this requirement. If no shop drawing is submitted, contractor shall be fully responsible for a complete installation and assumes all related costs that affects the contractor and other trades.

1.07 DRAWINGS AND SPECIFICATIONS

- A. The drawings are generally diagrammatic and necessary field coordination and adjustment must be provided by the contractor prior to installation. Such deviations to the work to allow for coordination shall be kept to a minimum and any such deviations shall be at no extra cost.
- B. When a conflict or contradiction exists either between drawings and specs or between specs or between different drawings or details, the more stringent shall apply.
- C. Drawings and specifications are intended to be taken as a whole and each is to supplement

the other. It is not intended that all work must be both shown on drawings and specified in the specifications.

- D. An item shown on the drawings and not indicated in the specifications is to be understood to be required for the project. An item specified and not shown on the drawings is to be understood to be required for the project.
- E. The contractor shall refer to the drawings for details which may influence the design of the fire suppression systems.
- F. The architects or engineer's interpretation of the documents shall be binding upon the contractor. If a question arises, the contractor shall ask for an interpretation prior to bidding and an answer shall be issued as an addendum to all bidders.
- G. If a question arises after bidding the A/E interpretation shall govern.

1.08 MEASUREMENTS

- A. Before ordering materials or commencing with any work, the contractor shall verify all measurements at the building. Coordination of equipment, materials, spaces, and dimensions are the responsibility of the contractor.

1.09 PROGRESS SCHEDULE

- A. Provide a project schedule which shall show start, sequence of each type of work, milestone schedule, and completion of each type of work, with overall completion date. Work involving interruption of services shall be clearly designated and approved.

1.10 COST SCHEDULE

- A. Provide a detailed cost breakdown indicating labor and material amounts for various types of work.
- B. AIA forms are required for this submission.

1.11 COMPLETION

- A. The contractor shall deliver to the owner, with his request for final payment, copies of all manufacturer's guarantees, equipment instructional manuals, a complete set of all final shop drawings, catalog cuts, service contracts, and other items as may be required elsewhere in the documents.

1.12 OFFICE

- A. The contractor shall set up his job office (desk) where directed by the owner.

1.13 STORAGE

- A. Material shall be stored only where directed by the owner.

1.14 SANITARY

- A. The contractor will at his own expense, provide and maintain in a sanitary condition, a portable chemical toilet.
- B. Toilet will be located where directed by the owner.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All material shall be new and of present day manufacture.
- B. All material and equipment shall be in conformance with accepted trade standards.
- C. Whenever equipment or material is referred to in the singular, such as "the fan", it shall be deemed to apply to as many such items as may be necessary to complete the installation.
- D. The word "provide" means "furnish and install complete, tested, and adjusted as necessary with all accessories, covers, escutcheons". The word "piping" means pipe, fitting, controls, valves, and hangers as required for a complete system.

2.02 EQUIPMENT START UP

- A. Verify that equipment is operating within warranty requirements.
- B. Advise owner and A/E at least two days prior.
- C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to A/E.
- D. Fire pump operation and testing to conform to applicable NFPA requirements.

2.03 LUBRICATION

- A. Lubricate all equipment in accordance with manufacturer's instructions.
- B. Lubricate prior to start up.
- C. Provide one year's supply of lubricants to the owner.

2.04 OPERATING INSTRUCTIONS AND MANUALS

- A. Properly and fully instruct owner's personnel in the operation and maintenance of all systems and equipment.
- B. Ensure that the owner's personnel are familiar with all operations to carry on required activities.
- C. Such instruction shall be for each item of equipment and each system as a whole.
- D. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, wiring diagrams, control sequences, service requirements, piping diagrams, names, and addresses of vendors, suppliers and emergency contacts. Three manuals shall be provided.
- E. Provide to the owner any special tools necessary to operate any of the equipment.

PART 3 - EXECUTION

3.01 PROTECTION

- A. Plug or cap open ends of piping systems.
- B. Stored materials shall be covered to prevent damage by inclement weather, sun, dust, or moisture.
- C. Protect all installed work until accepted in place by the owner.

- D. Do not install sprinklers, polished metal escutcheons, and other finished devices until masonry, tile, and painting operations are complete or protect otherwise.
- E. Protect all existing or new work from operations which may cause damage such as hauling, welding, and painting.

3.02 WORKMANSHIP

- A. Install all work neat, trim, and plumb with building lines.
- B. Install work in spaces allocated.
- C. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.

3.03 EXCAVATION, SHORING, PUMPING, BACKFILLING

- A. Perform all excavation required to install the work. Deposit excavated material so as not to create a slide hazard.
- B. No work shall be placed on rock. Cushion with 6 " layer of crushed stone.
- C. Protect tree roots with burlap covering and maintain moist until backfilled.
- D. Base estimates on excavation which will include earth, sand, clay, rubbish, debris, and all other materials up to one cubic yard in size. Boulders or rock larger than one cubic yard which need to be broken up with pneumatic equipment or explosives will be separately negotiated at the time of discovery with the owner and A/E. Do not proceed with rock excavation until an agreement is reached.
- E. Maintain excavations free of water.
- F. Shore excavations to prevent cave-in in accordance with OSHA regulations and to prevent strains on work put in place until ready to receive backfill.
- G. Backfill with clean material and pneumatically tamp in 8" layers. Remove excess material, including rock, from site or as directed by the A/E.
- H. Backfill piping trenches within 18" of footings, columns, piers, or grade beams, with concrete. Protect piping from direct contact and adherence to concrete.
- I. Return to original condition any areas disturbed for excavation.
- J. Provide pipe restraints as specified.

3.04 FASTENERS, HANGERS, AND SUPPORTS

- A. Furnish and install all hangers and supports required to suspend, mount, or hang the work per NFPA requirements.
- B. Furnish and install all miscellaneous steel angles, channels, beams, clips, brackets, and anchors to hang or support the work. Provide submissions for review.
- C. Install concrete inserts before concrete is poured.
- D. Drilled inserts shall not be loaded to more than 1/4 rated capacity with a minimum of 200 lbs.
- E. Power driven fasteners shall not be allowed for piping larger than 2", or for equipment. When used they shall not be loaded more than 1/8 rated capacity with a minimum of 200 lbs.
- F. Provide seismic restraint for piping as required by NFPA.

3.05 OFFSETS, TRANSITIONS, MODIFICATIONS

- A. Furnish and install all offsets necessary to install the work and to provide clearance for the other trades.
- B. Maintain adequate headroom and clearance as directed by the A/E.
- C. Incidental modifications necessary to the installation of the systems shall be made as

necessary and at the direction of the A/E.

- D. Rises and drops of piping systems shall be provided as required and where directed to allow for clearances to other construction. Drains shall be installed at no additional cost to the owner. The contractor shall allow for such occurrences in his bid.
- E. Piping, and equipment shall be so arranged as to not pass in front of windows, doors, access panels, access doors, and service clearance areas. Do not install within 3'-0" clearance of electrical or panel fronts.

3.06 EQUIPMENT SETTING

- A. Furnish and install as a minimum, a concrete pad beneath all floor mounted equipment in mechanical rooms or equipment rooms.
- B. Reinforce concrete with No. 4 rods 12" on centers both ways.
- C. Pad to have 3/4" dowels into concrete at 1 per 4 square feet.

3.07 ACCESS

- A. Locate all equipment, valves, devices, and controllers which may need service in accessible places.

3.08 WIRING

- A. Power wiring shall be provided by the Division 26 Electrical Contractor. This contractor shall furnish all controllers necessary to operate the equipment. The Electrical Contractor shall store and install the electrical devices and furnish and install the power wiring.
- B. Supervisory and alarm wiring shall be furnished and installed under Division 28 portion of the work.
- C. All wiring shall be in accordance with the NEC.
- D. Pushbuttons shall be maintain-contact type.
- E. Refer to the electrical specifications for wiring methods.
- F. Plenum rated cable is required for control wiring.

3.09 UTILITIES

- A. Do not interrupt any utility or service without adequate previous notice and scheduling with the owner.
- B. Refer to Division 1 for requirements for providing temporary utilities.

3.10 CUTTING AND PATCHING EXTERIOR SERVICES

- A. This contractor shall be responsible for returning disturbed areas to original condition where excavation for utilities has been required.
- B. Cut and patch paved areas to match original surfaces.
- C. Properly tamp backfill before finishing surfaces.
- D. Concrete pavements and curbs shall be formed and poured to match adjacent areas.
- E. Grass areas shall be sodded and maintained until established growth is achieved.

3.11 GUARANTEE

- A. All work shall be guaranteed to be free from defects for a period of one year of operation from date of acceptance by the owner unless otherwise specified. Material and labor for

- first year warranty is to be provided.
- B. Guarantee shall be extended for all non-operational periods due to failure within the guarantee period.

3.12 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver material and equipment in manufacturer's original cartons or on skids.
- B. Store material in dry enclosures or under protective coverings out of way of work progress.
- C. Handle so as to prevent damage to product or any surrounding material.

3.13 MANUFACTURER'S NAMES

- A. Manufacturers names are included herein to establish those suppliers who may provide products for this project subject to the requirements of the specifications. All material and equipment must be U.L. and FM approved. Any deviations from this must be acknowledged at bid time by the supplier and he shall be solely responsible for any and all costs associated with the application of his product in the project.

3.14 AS-BUILT DRAWINGS

- A. At the completion of the work the contractor shall furnish a reproducible as-built drawings to the A/E for approval. The drawings shall indicate all work installed and its actual size and location. If acceptable, the A/E will submit the as-built drawings to the owner as record drawings. If not acceptable, the A/E will return the drawing to the contractor to make corrections as required. The contractor will resubmit for approval.
- B. The as-built drawings shall indicate measured dimensions of underground lines and other concealed work.
- C. To aid in the preparation of as-built drawings, the engineer can provide the electronic files for use by the contractor. The electronic files will be provided upon execution of the engineer's electronic file release contract prepared specifically for this project. The electronic files will be released in the format used by the architect and engineer to design the project. If this file format is not compatible with the contractor's needs, additional charges for providing the changes to the requested file format may be necessary at \$150/hr. billable to the contractor.

3.15 PENETRATION SEALING

- A. All penetrations of fire walls, smoke walls, and floors by ducts, pipes, conduit, or wiring shall be sealed to prevent the flow of gasses or smoke.
- B. The sealant shall be foamed in place between the penetrant and the adjacent floor or wall with DOW Corning RTV foam or equivalent by 3M, Hilti, or Chase foam.
- C. The installation shall meet the approval of the authority having jurisdiction.
- D. Penetrations through rated surfaces shall have a UL rating equivalent to the adjacent surfaces.

3.16 CUTTING AND PATCHING INTERIOR SURFACES

- A. Respective contractor shall install all hangers, supports, pipe sleeves in floors, walls, partitions, ceilings, and roof slabs as construction progresses to permit their work to be built into place and to eliminate unnecessary cutting of construction work.
- B. All cutting of concrete, or other material for the passage of piping through floors, walls, partitions, and ceiling shall be done by the contractor where necessary to install his work.

Contractor will close all such openings around piping, and conduit with materials equivalent to that removed. All exposed surfaces shall be left in suitable condition for refinishing without further work.

- C. Contractor shall patch and repair any existing openings created by the demolition work in floors, walls, partitions, and ceilings not being reused for the new construction.

3.17 COORDINATION

- A. The sprinkler shop drawings shall show all ductwork, diffusers, grilles, piping, conduit lighting fixtures coordinated with the sprinkler piping and sprinkler beads.
- B. All architectural features, structural conditions which may impact on the sprinkler layout shall be shown.
- C. The location of equipment, controller, fire pumps, and jockey pumps compression and valve shall be coordinated with the other trades showing all necessary clearances.

3.18 WELDING

- A. All electric power for arc welding shall be supplied by the contractor performing the work.

3.19 VEHICLES

- A. Vehicle access to the site will be as directed by the owner.

3.20 RUBBISH DISPOSAL

- A. Burning of debris on the site shall not be permitted. All debris, refuse, and waste shall be removed from the premises at regular intervals. No accumulation shall be permitted.

3.21 PROTECTION

- A. Maintain all public walks and access ways.
- B. Erect and maintain barricades, warning signs, and other protective means as may be directed by the owner for protection of all persons and property from injury or damage.

3.22 SCAFFOLDING

- A. The contractor shall at his own expense, install, operate, protect, and maintain temporary services such as scaffolding, material hoists, access walks, etc., as may be required.

3.23 CLEANUP

- A. Remove all visible temporary tags or labels as well as any protective coverings and wrappings from equipment.
- B. Remove all spots, stains, soil, paint, spackle, and other foreign matter from all finished work.
- C. Remove all trash and debris from the premises.

3.24 WORK COMPLETION

- A. The contractor shall promptly correct work rejected by the engineer failing to conform to the requirements of the contract documents, whether discovered before or after substantial completion and whether or not fabricated, installed or completed. Costs of correcting such

rejected work, including additional testing and inspections and compensation for the engineer's services and expenses made necessary thereby, shall be at the contractor's expense.

3.25 REQUEST FOR INFORMATION (RFI) REQUIREMENTS

- A. All RFI's shall include the following information based on AIA Document G716:
1. To, From, Project Name, Issue Date, RFI number in sequential order with all other trades, Requested Reply Date.
 2. Provide a description with specification and/or drawing references.
 3. Provide the senders recommendation including cost and/or schedule considerations.
 4. Provide receiver's reply space.
 5. Note an RFI reply is not an authorization to proceed with the work involving additional cost/time.

3.26 SHOP DRAWING REQUIREMENTS

- A. The following is a list of required shop drawings for the project. Not all items may be identified, and it is the responsibility of the contractor to submit additional shop drawings where indicated in the specifications.

FIRE PROTECTION	DATE REC'D	ACTION	DATE REC'D	ACTION
COORDINATION DRAWINGS				
SPRINKLER SYSTEM HYDRAULIC CALCULATIONS AND DESIGN DRAWINGS AND DETAILS				
FIRE MARSHAL APPROVAL				
INSURANCE COMPANY APPROVAL				
SPRINKLER HEADS				
PIPING/VALVES/HANGERS				
FIRE PUMP & ACCESSORIES				
BACKFLOW PREVENTERS				
SPARE SPRINKLER CAP & SIGNS				
JOCKEY PUMP				
FIRE & JOCKEY PUMP CONTROLLERS				
SIAMESE CONNECTION				
WATER MOTOR GONG				
FLOW & TAMPER SWITCHES				

FIRE PROTECTION	DATE REC'D	ACTION	DATE REC'D	ACTION
AS-BUILTS				
WARRANTIES AND GUARANTEES				
AIR COMPRESSOR & RECEIVER				
OPERATIONS AND MAINTENANCE MANUALS				
TESTS/CERTIFICATIONS				
EMERGENCY AND MANUFACTURER CONTACTS				
CONTRACTOR'S LETTER OF COMPLETION				
FIRE PUMP TEST REPORT				

END OF SECTION

SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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.

2.02 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
 - 4. Metraflex Company (The).
 - 5. Proco Products, 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: Carbon steel or Plastic.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.03 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

3.01 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. 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.
 - 2. 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 architectural specifications sections.
- 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 architectural specifications sections.

3.02 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.

3.03 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-inch: Cast-iron wall sleeves or Galvanized-steel wall sleeves.
 - b. Piping NPS 6-inch and Larger: Cast-iron wall sleeves or Galvanized-steel wall sleeves.
2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6-inch: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6-inch and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6-inch: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6-inch and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6-inch: Galvanized-steel-pipe sleeves or PVC-pipe sleeves.
 - b. Piping NPS 6-inch and Larger: Galvanized-steel-pipe sleeves or PVC-pipe sleeves.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6-inch: Galvanized-steel-pipe sleeves or PVC-pipe sleeves.
 - b. Piping NPS 6-inch and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 21 05 18 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

- A. One Piece, Cast-Brass Type: With [polished, chrome-plated] [and] [rough-brass] finish and setscrew fastener.
- B. One Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.02 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange [with holes for fasteners].

PART 3 - EXECUTION

3.01 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:
 - 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.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece,

- e. cast-brass type with polished, chrome-plated finish.
Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with [polished, chrome-plated] [rough-brass] finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with [polished, chrome-plated] [rough-brass] finish.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- 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: One-piece, floor-plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 21 05 23 - GENERAL-DUTY VALVES FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Iron butterfly valves with indicators.
 - 2. Check valves.
 - 3. Iron OS&Y gate valves.
 - 4. NRS gate valves.
 - 5. Indicator posts.
 - 6. Trim and drain valves.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
 - 1. Main Level: HAMV - Fire Main Equipment.
 - a. Level 1: HCBZ - Indicator Posts, Gate Valve.
 - b. Level 1: HLOT - Valves.
 - 1) Level 3: HLUG - Ball Valves, System Control.
 - 2) Level 3: HLXS - Butterfly Valves.
 - 3) Level 3: HMER - Check Valves.
 - 4) Level 3: HMRZ - Gate Valves.
 - 2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
 - a. Level 1: VQGU - Valves, Trim and Drain.
- B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
 - 1. Automated Sprinkler Systems:
 - a. Indicator posts.
 - b. Valves.
 - 1) Gate valves.
 - 2) Check valves.
 - a. Single Check Valves
 - c. Miscellaneous valves.
- C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.
- D. ASME Compliance:
 - 1. ASME B16.1 for flanges on iron valves.

- 2. ASME B1.20.1 for threads for threaded-end valves.
- 3. ASME B31.9 for building services piping valves.
- E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- F. NFPA Compliance: Comply with NFPA 24 for valves.
- G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.
- H. Valve Sizes: Same as upstream piping unless otherwise indicated.
- I. Valve Actuator Types:
 - 1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
 - 2. Handwheel: For other than quarter-turn trim and drain valves.
 - 3. Handlever: For quarter-turn trim and drain valves NPS 2-inch and smaller.

2.02 IRON BUTTERFLY VALVES WITH INDICATORS

- 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. Globe Fire Sprinkler Corporation.
 - 2. NIBCO INC.
 - 3. Tyco Fire Products LP.
 - 4. Victaulic Company.
- B. Description:
 - 1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
 - 2. Minimum Pressure Rating: 175 psig.
 - 3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
 - 4. Seat Material: EPDM.
 - 5. Stem: Stainless steel.
 - 6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
 - 7. Actuator: Worm gear or traveling nut.
 - 8. Supervisory Switch: Internal or external.
 - 9. Body Design: Grooved-end connections.

2.03 CHECK VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Globe Fire Sprinkler Corporation.
 - 2. Mueller Co.
 - 3. NIBCO INC.
 - 4. Reliable Automatic Sprinkler Co., Inc. (The).
 - 5. Tyco Fire Products LP.
 - 6. Victaulic Company.
 - 7. Viking Corporation.
- B. Description:
 - 1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
 - 2. Minimum Pressure Rating: 175 psig.
 - 3. Type: Single swing check.
 - 4. Body Material: Cast iron, ductile iron, or bronze.
 - 5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.

6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.04 IRON OS&Y GATE VALVES

- 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. Hammond Valve.
 2. Mueller Co.
 3. NIBCO INC.
 4. Victaulic Company.
- B. Description:
 1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
 2. Minimum Pressure Rating: 175 psig.
 3. Body and Bonnet Material: Cast or ductile iron.
 4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
 5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
 6. Stem: Brass or bronze.
 7. Packing: Non-asbestos PTFE.
 8. Supervisory Switch: External.
 9. End Connections: Grooved.

2.05 NRS GATE VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Mueller Co.
 2. NIBCO INC.
 3. Victaulic Company.
- B. Description:
 1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
 2. Minimum Pressure Rating: 175 psig.
 3. Body and Bonnet Material: Cast or ductile iron.
 4. Wedge: Cast or ductile iron with elastomeric coating.
 5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
 6. Stem: Brass or bronze.
 7. Packing: Non-asbestos PTFE.
 8. Supervisory Switch: External.
 9. End Connections: Grooved.

2.06 TRIM AND DRAIN VALVES

- A. Angle Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire Protection Products, Inc.
 - b. NIBCO INC.

- c. United Brass Works, Inc.
- 2. Description:
 - a. Pressure Rating: 175 psig.
 - b. Body Material: Brass or bronze.
 - c. Ends: Threaded.
 - d. Stem: Bronze.
 - e. Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

- A. Comply with requirements in the following Sections for specific valve installation requirements and applications:
 - 1. Section 211100 "Facility Fire Suppression Water-Service Piping" for application of valves in fire-suppression water service piping outside the building.
 - 2. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
 - 3. Section 211316 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.
- 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. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the pipe center.
- F. Install valves in position to allow full stem movement.
- G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.
- H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

END OF SECTION

SECTION 21 05 53 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Seton Identification Products.
 - 2. Material and Thickness: Brass, 0.032 inch, stainless steel, 0.025 inch, aluminum, 0.032 inch or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
 - 3. Minimum Label Size: Length and width vary for required label content, but not less than 2 ½ by ¾ inch.
 - 4. 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.
 - 5. Fasteners: Stainless-steel.
 - 6. Adhesive: Contact type permanent adhesive, compatible with label and with

- substrate.
- B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Seton Identification Products.
 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
 3. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
 4. Minimum Label Size: Length and width vary for required label content, but not less than 2 ½ by ¾ inch.
 5. 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.
 6. Fasteners: Stainless steel.
 7. 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.
- D. Equipment-Label Schedule: For each item of equipment to be labeled, on 8 ½ by 11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Carlton Industries, LP.
 4. Champion America.
 5. Craftmark Pipe Markers.
 6. emedco.
 7. LEM Products Inc.
 8. Marking Services Inc.
 9. National Marker Company.
 10. Seton Identification Products.
 11. Stranco, Inc.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16

- inch thick, with predrilled holes for attachment hardware.
- C. Letter Color: Red.
 - D. Background Color: Red.
 - E. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
 - F. Minimum Label Size: Length and width vary for required label content, but not less than 2 ½ by ¾ inch.
 - G. 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.
 - H. Fasteners: Stainless steel.
 - I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
 - J. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP.
 - 5. Champion America.
 - 6. Craftmark Pipe Markers.
 - 7. emedco.
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Services Inc.
 - 11. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover 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, 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 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

PART 3 - EXECUTION

3.01 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.

3.02 LABEL INSTALLATION 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 or permanently fasten labels on each major item of mechanical equipment.
- D. Locate equipment labels where accessible and visible.
- E. Piping: Painting of piping is specified in Architectural Specification Sections or minimally (2) coats of exterior paint and (1) primer coat.
- F. 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. Near each valve and control device.
 - 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit a 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.

END OF SECTION

SECTION 21 11 00 - FACILITY FIRE SUPPRESSION WATER-SERVICE PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes fire suppression water service piping and related components outside the building and service entrance piping through floor into the building and service entrance piping through wall into the building and the following:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire suppression specialty valves.
 - 3. Concrete vaults.
 - 4. Protective enclosures.
 - 5. Alarm devices.
- B. Utility-furnished products include water meters that are furnished to the site, ready for installation.
- C. Related Requirements:
 - 1. Section 211200 "Fire Suppression Standpipes" for fire suppression standpipes inside the building.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
 - 2. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- B. Field quality control reports.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of utility company supplying the water. Include tapping of water mains and backflow prevention.
 - 2. Comply with standards of authorities having jurisdiction for fire-suppression water service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- 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. Comply with FM Global's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and

valve and hydrant supervision for fire-suppression water-service piping.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
- B. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B), water tube, drawn temper.
- C. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- D. Copper, Pressure-Seal Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Viega LLC or prior approved equal.
 - 2. Standard: UL 213.
 - 3. NPS 2-inch and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - 4. NPS 2-1/2-1 inch to NPS 4-inch: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- 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.

2.02 DUCTILE-IRON PIPE AND FITTINGS

- A. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
- B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end.
- C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end.
- D. Grooved-End, Ductile-Iron Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Star Pipe Products.
 - c. Tyco Fire Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.
 - 2. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
 - 3. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- E. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

- F. Push-on-Joint, Ductile-Iron Fittings: AWWA C153, ductile-iron compact pattern.
 - 1. Gaskets: AWWA C111, rubber.
- G. Flanges: ASME B16.1, Class 125, cast iron.

2.03 PE PIPE AND FITTINGS

- A. PE, Fire-Service Pipe: FM Global approved, with minimum thickness equivalent to Class 150 and Class 200.
- B. Molded PE Fittings: FM Global approved; PE butt-fusion type, made to match PE pipe dimensions and class.

2.04 SPECIAL PIPE FITTINGS

- A. Ductile-Iron Flexible Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. EBAA Iron, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products.
 - d. Zurn Industries, LLC.
 - 2. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
 - 3. Pressure Rating: 250 psig minimum.
- B. Ductile-Iron Deflection Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. EBAA Iron, Inc.
 - 2. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-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.
 - 3. Pressure Rating: 250 psig minimum.

2.05 JOINING MATERIALS

- A. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.
- B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.

2.06 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser, Inc.
 - c. Ford Meter Box Company, Inc. (The).

- d. Jay R. Smith Mfg. Co.
- e. JCM Industries, Inc.
- f. Romac Industries, Inc.
- g. Viking Johnson.
- 2. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners, and with ends of same sizes as piping to be joined.
- 3. Standard: AWWA C219.
- 4. Center-Sleeve Material: Manufacturer's standard
- 5. Gasket Material: Natural or synthetic rubber.
- 6. Pressure Rating: 150 psig minimum.
- 7. Metal Component Finish: Corrosion-resistant coating or material.

2.07 CORPORATION VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A.Y. McDonald Mfg. Co.
 - 2. Ford Meter Box Company, Inc. (The).
 - 3. Jones, James Company.
 - 4. Master Meter, Inc.
 - 5. Mueller Co.
 - 6. Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.
- B. Corporation Valves: Comply with AWWA C800. Include saddle and valve compatible with tapping machine and manifold.
 - 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 - 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
 - 3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- C. Meter Valves: Comply with AWWA C800 for high-pressure, service-line valves. Include angle- or straight-through-pattern bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

2.08 CURB VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. A.Y. McDonald Mfg. Co.
 - 2. Ford Meter Box Company, Inc. (The).
 - 3. Jones, James Company.
 - 4. Master Meter, Inc.
 - 5. Mueller Co.
 - 6. Red Hed Manufacturing Company; a division of Everett J. Prescott, Inc.
- B. Curb Valves: Comply with AWWA C800 for high-pressure, service-line valves. Valve has bronze body, ground-key plug or ball, wide tee head, and inlet and outlet matching service piping material.
- C. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with

a barrel approximately 3 inches in diameter.

1. Shutoff Rods: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.
- D. Meter Valves: Comply with AWWA C800 for high-pressure, service-line valves. Include angle- or straight-through-pattern bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

2.09 DETECTOR CHECK VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ames Fire & Waterworks.
 2. Badger Meter, Inc.
 3. FEBCO.
 4. Globe Fire Sprinkler Corporation.
 5. Mueller Co.
 6. Victaulic Company.
 7. Viking Corporation.
 8. Watts; a Watts Water Technologies company.
 9. Zurn Industries, LLC.
- B. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
- C. Standards: UL 312 and FM Global's "Approval Guide."
- D. Pressure Rating: 175 psig.
- E. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2.10 WATER METERS

- A. Water meters are furnished by utility company.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMCO Water Metering Systems.
 2. Badger Meter, Inc.
 3. Mueller Co.
 4. Neptune Technology Group Inc.
 5. Sensus Metering Systems.
- C. Displacement-Type Water Meters:
1. Description: With bronze main case.
 2. Standard: AWWA C700.
 3. Registration: Flow in gallons.
- D. Turbine-Type Water Meters:
1. Standard: AWWA C701.
 2. Registration: Flow in gallons.
- E. Compound-Type Water Meters:
1. Standard: AWWA C702.
 2. Registration: Flow in gallons.

- F. Remote Registration System:
1. Description: Utility company's standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
 2. Standard: AWWA C706.
 3. Registration: Flow in gallons.
- G. Remote Registration System:
1. Description: Utility company's standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
 2. Standard: AWWA C707.
 3. Registration: Flow in gallons.
 4. Data-Acquisition Units: Comply with utility company's requirements for type and quantity.
 5. Visible Display Units: Comply with utility company's requirements for type and quantity.

2.11 PRESSURE-REDUCING VALVES

- A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Honeywell Water Controls.
 - c. Watts; a Watts Water Technologies company.
 - d. Zurn Industries, LLC.
 2. Standard: ASSE 1003.
 3. Pressure Rating: Initial pressure of 150 psig.
 4. Body Material: Bronze with chrome-plated finish for NPS 2-inch and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2 ½ -inch and NPS 3-inch.
 5. End Connections: Threaded for NPS 2-inch and smaller; flanged for NPS 2 ½ -inch and NPS 3-inch.
- B. Water Control Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Use water company approved manufacturer/model.
 - a. Ames Fire & Waterworks.
 - b. CLA-VAL Automatic Control Valves.
 - c. Globe Fire Sprinkler Corporation.
 - d. Reliable Automatic Sprinkler Co., Inc. (The).
 - e. Tyco Fire Products LP.
 - f. Victaulic Company.
 - g. Viking Corporation.
 - h. Watts; a Watts Water Technologies company.
 - i. Zurn Industries, LLC.
 2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
 3. Pressure Rating: Initial pressure of 150 psig minimum.
 4. Main Valve Body: Cast or ductile iron with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

- a. Pattern: Angle or Globe-valve design.
- b. Trim: Stainless steel.
- 5. End Connections: Threaded for NPS 2-inch and smaller; flanged for NPS 2 ½ -inch and larger.

2.12 BACKFLOW PREVENTERS

- A. Double-Check, Backflow-Prevention Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: (Provide water company approved manufacturer/Model)
 - a. Ames Fire & Waterworks.
 - b. Apollo Valves; Conbraco Industries, Inc.
 - c. FEBCO.
 - d. Mueller Co.
 - e. Watts; a Watts Water Technologies company.
 - f. Zurn Industries, LLC.
 - 2. Standard: ASSE 1015 or AWWA C510.
 - 3. Operation: Continuous-pressure applications unless otherwise indicated.
 - 4. Pressure Loss: 5 psig maximum, through middle one-third of flow range.
 - 5. Body Material: Bronze for NPS 2-inch and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2 ½ -inch and larger.
 - 6. End Connections: Threaded for NPS 2-inch and smaller; flanged for NPS 2 ½ -inch and larger.
 - 7. Configuration: Designed for straight through flow.
 - 8. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2-inch and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2 ½ -inch and larger.
- B. Double-Check, Detector-Assembly Backflow Preventers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Fire & Waterworks.
 - b. Apollo Valves; Conbraco Industries, Inc.
 - c. FEBCO.
 - d. Mueller Co.
 - e. Watts; a Watts Water Technologies company.
 - f. Zurn Industries, LLC.
 - 2. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
 - 3. Operation: Continuous-pressure applications.
 - 4. Pressure Loss: 5 psig maximum, through middle one-third of flow range.
 - 5. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
 - 6. End Connections: Flanged.
 - 7. Configuration: Designed for straight through flow.
 - 8. Accessories:
 - a. Valves: UL 262 and FM Global's "Approval Guide" listing; OS&Y gate type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- C. Backflow Preventer Test Kits:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of

the following:

- a. Apollo Valves; Conbraco Industries, Inc.
 - b. FEBCO.
 - c. Watts; a Watts Water Technologies company.
 - d. Zurn Industries, LLC.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.13 WATER METER BOXES

- A. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" on cover; and with slotted, open-bottom base section of length to fit over service piping.
1. Option: Base section may be cast-iron, PVC, clay, or other pipe.
- B. Description: Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" on top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
- C. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" on cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb. minimum over 10 by 10 inches square.

2.14 CONCRETE VAULTS

- A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857, and made according to ASTM C 858.
- B. Ladder: ASTM A 36/A 36M, steel ladder; or PE-encased steel steps.
- C. Manhole: ASTM A 48/A 48M, Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
1. Dimension: 24-inch minimum diameter unless otherwise indicated.
- D. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
1. Dimension: 24-inch minimum diameter unless otherwise indicated.
- E. Drain: ASME A112.6.3, cast-iron floor drains with outlet of size indicated, Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.15 ALARM DEVICES

- A. General: UL 753 and FM Global's "Approval Guide" listing, of types and sizes to mate and match piping and equipment.
- B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psig working pressure; designed for horizontal or vertical installation; with two single-pole, double-throw circuit switches to provide 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 when cover is removed.
- C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.
- D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

PART 3 - EXECUTION**3.01 EARTHWORK**

- A. Comply with excavating, trenching, and backfilling requirements in architectural specification sections.

3.02 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with water utility company for tap of size and in location indicated in water main.
- B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- C. Make connections larger than NPS 2-inch with tapping machine according to the following:
 - 1. Install tapping sleeve and tapping valve according to MSS SP-60.
 - 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 - 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 - 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- D. Make connections NPS 2-inch and smaller with drilling machine according to the following:
 - 1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company's standards.
 - 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 - 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 - 4. Install corporation valves into service-saddle assemblies.
 - 5. Install manifold for multiple taps in water main.
 - 6. Install curb valve in water-service piping with head pointing up and with service box.
- E. Comply with NFPA 24 for fire-service-main piping materials and installation.
- F. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- G. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
 - 1. Install encasement for piping according to ASTM A 674 or AWWA C105.
- H. Install PE pipe according to ASTM D 2774 and ASTM F 645.
- I. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- J. Bury piping with depth of cover over top at least 36 inches with top at least 12 inches below level of maximum frost penetration, and according to the following:
 - 1. Under Driveways: With at least 36 inches of cover over top.
 - 2. Under Railroad Tracks: With at least 48 inches of cover over top.
 - 3. In Loose Gravelly Soil and Rock: With at least 12 inches of additional cover.
- K. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- L. Extend fire-suppression water-service piping and connect to water-supply source and building fire-suppression water-service piping systems at locations and pipe sizes indicated.
 - 1. Terminate fire-suppression water-service piping within the building at the floor slab or wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire-suppression water-service piping systems when those systems are installed.
- M. Install underground piping with restrained joints at horizontal and vertical changes in

direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

- N. Comply with requirements in Section 211200 "Fire Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for fire-suppression water piping inside the building.
- O. Comply with requirements in Section 221116 "Domestic Water Piping" for potable-water piping inside the building.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.

3.03 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in tubing NPS 2-inch and smaller.
- C. Install flanges, flange adaptors, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2 ½-inch and larger end connections.
- D. Ream ends of tubes and remove burrs.
- E. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.
- F. Copper-Tubing, Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- G. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
- H. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
- I. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts.
- J. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with bolts according to ASME B31.9.
- K. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
- L. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139.
- M. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.
- N. Do not use flanges or unions for underground piping.

3.04 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Heat-fused joints.
 - 6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs, and caps, bends, crosses, valves, and hydrant branches in fire-suppression water-service piping according to NFPA 24 and the following:
 - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.05 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
- G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass.
- H. Support valves and piping, not direct buried, on concrete piers.

3.06 DETECTOR CHECK VALVE INSTALLATION

- A. Install in vault or aboveground.
- B. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
- C. Support detector check valves and piping on concrete piers.

3.07 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written instructions.
- B. Water Meters: Install turbine-type water meters NPS 2-inch and smaller in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and include valved bypass around meters unless prohibited by authorities having jurisdiction.
- C. Water Meters: Install compound or turbine-type water meters NPS 3-inch and larger in meter vaults. Include shutoff valves on water meter inlets and outlets and include valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
- D. Support water meters and piping NPS 3-inch and larger on concrete piers.

3.08 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.

3.09 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2 ½ - inch and larger backflow preventers and piping on concrete piers.

3.10 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891.

3.11 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install ball drip valves at each check valve for fire-department connection to mains.
- B. Install protective pipe bollards on three sides of each freestanding fire-department connection. Pipe bollards are specified in Architectural Specification Sections.

3.12 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
- B. Supervisory Switches: Supervise valves in open position.
 - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:
 - 1. Valves: Install chain and padlock on open OS&Y gate valve.
 - 2. Post Indicators: Install padlock on wrench on indicator post.
- D. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
- E. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- F. Connect alarm devices to building's fire-alarm system.

3.13 CONNECTIONS

- A. Connect fire-suppression water-service piping to utility water main or existing water main. Use tapping sleeve and tapping valve.
- B. Connect fire-suppression water-service piping to interior fire-suppression piping.
- C. Connect waste piping from concrete vault drains to sanitary sewerage system.

3.14 FIELD QUALITY CONTROL

- A. Use test procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described below.
- B. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- C. Hydrostatic Tests: Test at not less than one-and-one-half times the working pressure for two hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to zero psig (zero kPa). Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

- D. Prepare test and inspection reports.

3.15 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground fire-suppression water-service piping. Locate below finished grade, directly over piping.
- B. Permanently attach equipment nameplate or marker indicating plastic fire-suppression water-service piping or fire-suppression water-service piping with electrically insulated fittings, on main electrical meter panel. Comply with requirements for identifying devices in Section 210553 "Identification for Fire Suppression Piping and Equipment."

3.16 PIPING SCHEDULE

- A. Underground fire-suppression water-service piping NPS 2-inch and smaller shall be one of the following:
1. NPS 2-inch PE, Class 150, fire-service pipe; molded PE fittings; and heat-fusion joints.
- B. Underground fire-suppression water-service piping NPS 3-inch shall be one of the following:
1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
 2. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
- C. Underground fire-suppression water-service piping NPS 4-inch shall be one of the following:
1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
 3. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
 4. PE, Class 150, fire-service pipe; molded PE fittings; and heat-fusion joints.
 5. PVC, Class 150 pipe listed for fire-protection service; PVC fittings of same class as pipe; and gasketed joints.
- D. Underground fire-suppression water-service piping NPS 6-inch to NPS 12-inch shall be one of the following:
1. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and gasketed joints.
 2. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron compact-pattern fittings; and gasketed joints.
- E. Aboveground and vault fire-suppression water-service piping NPS 2-inch and smaller shall be hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) wrought- or cast-copper-alloy, solder-joint fittings, and brazed joints.
- F. Aboveground and vault fire-suppression water-service piping NPS 3-inch and NPS 4-inch shall be one of the following:
1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
- G. Aboveground and vault fire-suppression water-service piping NPS 5-inch to NPS 12-inch shall be grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and

- grooved joints.
- H. Underslab fire-suppression water-service piping NPS 2-inch and smaller shall be soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) wrought-copper, solder-joint fittings, and brazed joints.
 - I. Underslab fire-suppression water-service piping NPS 3-inch and NPS 4-inch shall be one of the following:
 - 1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 - 2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and restrained, gasketed joints.
 - J. Underslab fire-suppression water-service piping NPS 6-inch to NPS 12-inch shall be one of the following:
 - 1. Grooved-end, ductile-iron pipe; grooved-end, ductile-iron pipe appurtenances; and grooved joints.
 - 2. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile- or gray-iron, standard-pattern or ductile-iron, compact-pattern fittings; glands, gaskets, and bolts; and restrained, gasketed joints.

3.17 VALVE SCHEDULE

- A. Underground fire-suppression water-service shutoff valves NPS 2-inch and smaller shall be corporation valves or curb valves with ends compatible with piping.
- B. Vault fire-suppression water-service shutoff valves NPS 2-inch and smaller shall be less 125, MSS, bronze, nonrising stem or UL-listed or FM Global-approved, OS&Y, bronze, gate valves.
- C. Underground fire-suppression water-service shutoff valves NPS 3-inch and larger shall be one of the following:
 - 1. 200-psig AWWA, iron, nonrising-stem, metal resilient-seated gate valves.
 - 2. 250-psig AWWA, iron, nonrising-stem, resilient-seated gate valves.
- D. Indicator-post underground fire-suppression water-service valves NPS 3-inch and larger shall be 175-psig, UL-listed or FM Global-approved, iron, nonrising-stem gate valves with indicator-post flange.
- E. Standard-pressure, aboveground and vault fire-suppression water-service shutoff valves NPS 3-inch and larger shall be one of the following:
 - 1. 200-psig, AWWA, iron, OS&Y, metal, or resilient-seated gate valves.
 - 2. 250-psig, AWWA, iron, OS&Y, resilient-seated gate valves.
- F. Fire-suppression water-service check valves NPS 3-inch and larger shall be one of the following:
 - 1. AWWA or UL-listed or FM Global-approved check valves.

END OF SECTION

SECTION 21 11 19 - FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Exposed type fire department connections.
 - 2. Flush type fire department connections.

1.02 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 each fire department connection.

PART 2 - PRODUCTS

2.01 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Fire Hose & Cabinet.
 - 2. Elkhart Brass Mfg. Co., Inc.
 - 3. Fire Protection Products, Inc.
 - 4. Fire-End & Croker Corporation.
 - 5. Guardian Fire Equipment, Inc.
- B. Standard: UL 405.
- C. Type: Exposed, projecting, for wall mounting.
- D. Pressure Rating: 175 psig minimum.
- E. Body Material: Corrosion resistant metal.
- F. Inlets: Brass with threads according to NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- G. Caps: Brass, lugged type, with gasket and chain.
- H. Escutcheon Plate: Round, brass, wall type.
- I. Outlet: Back, with pipe threads.
- J. Number of Inlets: Two.
- K. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
- L. Outlet Size: NPS 4-inch.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install wall-type fire department connections.
- B. Install automatic (ball-drip) drain valve at each check valve for fire department connection.

END OF SECTION

SECTION 21 13 16 - DRY-PIPE SPRINKLER SYSTEMS

PART 1 - PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Specialty valves.
 - 3. Sprinkler specialty pipe fittings.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Pressure gages.
- B. Related Requirements:
 - 1. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For dry-pipe sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Valving
 - 4. Main riser details
 - 5. Siamese connections
 - 6. Water motor gong
 - 7. Ball drip
 - 8. Sprinkler locations and types
 - 9. Fire hose locations
 - 10. Hydraulic reference points
 - 11. Hanger locations
 - 12. Pipe sizes
 - 13. Drain valves and inspector's test connections.
 - 14. Most remote hydraulic area
 - 15. Flow switches
 - 16. Tamper switches
 - 17. Pressure switches
- C. Delegated-Design Submittal: For dry-pipe 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.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which items of other systems and equipment are shown and coordinated with each other, using input from installers of the items involved.

- B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- C. 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."
- D. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler 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 a qualified professional engineer.
 - 2. Contractor shall be fully licensed and accredited in the installation of automatic sprinkler and related fire protection equipment for a minimum of 5 years and shall be regularly engaged in this trade.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTIONS

- A. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from opened sprinklers.

2.02 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13.
 - 2. NFPA 13R.
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Delegated Design: Engage a qualified professional engineer, with minimum 5 years' experience, to design wet-pipe sprinkler systems.
- D. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Automobile Parking Areas: Ordinary Hazard, Group 1
 - b. Building Service Areas: Ordinary Hazard, Group 1.

- c. Churches: Light Hazard.
- d. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
- e. Dry Cleaners: Ordinary Hazard, Group 2.
- f. General Storage Areas: Ordinary Hazard, Group 1.
- g. Laundries: Ordinary Hazard, Group 1
- h. Libraries except Stack Areas: Light Hazard.
- i. Library Stack Areas: Ordinary Hazard, Group 2.
- j. Machine Shops: Ordinary Hazard, Group 2.
- k. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
- l. Office and Public Areas: Light Hazard.
- m. Plastics Processing Areas: Extra Hazard, Group 2.
- n. Printing Plants: Extra Hazard, Group 1.
- o. Repair Garages: Ordinary Hazard, Group 2.
- p. Restaurant Service Areas: Ordinary Hazard, Group 1.
- q. Solvent Cleaning Areas: Extra Hazard, Group 2.
- r. Upholstering Plants: Extra Hazard, Group 1.
- 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
- 4. Maximum Protection Area per Sprinkler: According to UL listing.
- 5. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 120 sq. ft.
 - b. Storage Areas: 130 sq. ft.
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
- 6. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes
- E. Provide water curtains where glass is incorporated as part of interior fire rated partitions as described in NFPA-13.
- F. In multi-story buildings, the sprinkler system for each floor shall be provided with sectionalizing valves, flow switches, and combination drain and inspectors test connections.
- G. Concealed spaces in buildings having combustible construction shall be protected with sprinklers.
- H. All sprinkler systems shall have a 10 PSI factor of safety included in the sprinkler design.

2.03 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Pipe ends may be factory or field formed to match joining method.
- B. Schedule 30, Galvanized-Steel Pipe: ASTM A 135/A 135M; ASTM A 795/A 795M, or ASME B36.10M wrought steel, with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
- C. ASTM A 135/A 135M or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- D. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight,

- seamless steel pipe with threaded ends.
- E. Galvanized-Steel Couplings: ASTM A 865/A 865M, threaded.
 - F. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
 - G. Malleable- or Ductile-Iron Unions: UL 860.
 - H. Cast-Iron Flanges: ASME B16.1, Class 125.
 - I. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Shurjoint Piping Products.
 - J. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. National Fittings, Inc.
 - b. Tyco Fire Products LP.
 - c. Victaulic Company.
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 - 4. 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.

2.04 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Specialty Valves Pressure Rating: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Dry-Pipe Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc. (The).
 - c. Tyco Fire Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.
 - 2. Standard: UL 260.
 - 3. Design: Differential-pressure type.
 - 4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - 5. Air-Pressure Maintenance Device:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Globe Fire Sprinkler Corporation.
 - 2) Reliable Automatic Sprinkler Co., Inc. (The).
 - 3) Tyco Fire Products LP.
 - 4) Victaulic Company.

- 5) Viking Corporation.
 - b. Standard: UL 260.
 - c. Type: Automatic device to maintain minimum air pressure in piping.
 - d. 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 adjustable range, and 175-psig outlet pressure.
- 6. Air Compressor:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Gast Manufacturing Inc.
 - 2) General Air Products, Inc.
 - 3) Viking Corporation.
 - b. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - c. Motor Horsepower: Fractional.
 - d. Power: 120-V ac, 60 Hz, single phase.
- G. Automatic (Ball Drip) Drain Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products LP.
 - 2. Standard: UL 1726.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Type: Automatic draining, ball check.
 - 5. Size: NPS 3/4 -inch.
 - 6. End Connections: Threaded.

2.05 SPRINKLER PIPING SPECIALTIES

- A. General Requirements for Dry-Pipe System Fittings: UL listed for dry-pipe service.
- B. Branch Outlet Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. National Fittings, Inc.
 - b. Tyco Fire Products LP.
 - c. Victaulic Company.
 - 2. Standard: UL 213.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 5. Type: Mechanical-tee and -cross fittings.
 - 6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 - 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 - 8. Branch Outlets: Grooved, plain-end pipe, or threaded.
- C. Flow Detection and Test Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc.
 - b. Reliable Automatic Sprinkler Co., Inc. (The).
 - c. Tyco Fire Products LP.

- d. Victaulic Company.
- 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- 3. Pressure Rating: 175-psig minimum.
- 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
- 5. Size: Same as connected piping.
- 6. Inlet and Outlet: Threaded.
- D. Branch Line Testers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire-End & Croker Corporation.
 - 2. Potter Roemer LLC.
 - 3. Standard: UL 199.
 - 4. Pressure Rating: 175-psig minimum.
 - 5. Body Material: Brass.
 - 6. Size: Same as connected piping.
 - 7. Inlet: Threaded.
 - 8. Drain Outlet: Threaded and capped.
 - 9. Branch Outlet: Threaded, for sprinkler.
- E. Sprinkler Inspector's Test Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc.
 - b. Triple R Specialty.
 - c. Tyco Fire Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.
 - 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Body Material: Cast- or ductile-iron housing with sight glass.
 - 5. Size: Same as connected piping.
 - 6. Inlet and Outlet: Threaded.
- F. Adjustable Drop Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CECA, LLC.
 - b. Corcoran Piping System Co.
 - c. Merit Manufacturing.
 - 2. Standard: UL 1474.
 - 3. Pressure Rating: 250-psig minimum.
 - 4. Body Material: Steel pipe with EPDM O-ring seals.
 - 5. Size: Same as connected piping.
 - 6. Length: Adjustable.
 - 7. Inlet and Outlet: Threaded.
- G. Flexible Sprinkler Hose Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fivalco Inc.

- b. FlexHead Industries, Inc.
- c. Gateway Tubing, Inc.
- d. Victaulic Company.
- 2. Standard: UL 1474.
- 3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
- 4. Pressure Rating: 175-psig minimum.
- 5. Size: Same as connected piping, for sprinkler.

2.06 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Globe Fire Sprinkler Corporation.
 - 2. Reliable Automatic Sprinkler Co., Inc. (The).
 - 3. Tyco Fire Products LP.
 - 4. Venus Fire Protection Ltd.
 - 5. Victaulic Company.
 - 6. Viking Corporation.
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- C. Pressure Rating for Residential Sprinklers: 175-psig maximum.
- D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- E. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.
- F. Automatic Sprinklers with Heat-Responsive Element:
 - 1. Nonresidential Applications: UL 199.
 - 2. Residential Applications: UL 1626.
 - 3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- G. Sprinkler Finishes: Chrome plated bronze and painted.
- H. Special Coatings: Wax, lead and corrosion-resistant paint.
- I. 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.
 - 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- J. Sprinkler Guards:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 - 2. Standard: UL 199.
 - 3. Type: Wire cage with fastening device for attaching to sprinkler.
- K. Sprinkler heads at the top of the elevator shaft shall be rated at 200°F. Sprinklers in swimming pools shall be rated for corrosive environments standard to venting's electroless nickel plated sprinklers.
- L. Sprinkler heads in refrigerated boxes with temperatures below 40°F shall be dry pendants.
- M. Provide an allowance for an additional 12 heads and piping to cover architectural review and adjustment at shop drawing review. Design shall follow building lines, centers, and

architectural features for a uniform, coordinated appearance.

2.07 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AGF Manufacturing Inc.
 - 2. AMETEK, Inc.
 - 3. Ashcroft Inc.
 - 4. Brecco Corporation.
 - 5. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3 ½ to 4 ½ - inch diameter.
- D. Pressure Gage Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

2.08 SPRINKLER HEAD CABINET

- A. Cold rolled steel, red enamel box, labeled "SPRINKLER HEADS", storage for 12 sprinkler heads, hinged cover.
- B. Complete with 12 sprinklers of the type used on the project.
- C. Located at the fire service entrance, wall mounted.

PART 3 - EXECUTION

3.01 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements in Section 211100 "Facility Fire-Suppression Water-Service Piping" for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Section 211100 "Facility Fire-Suppression Water-Service Piping."
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.02 PIPING INSTALLATION

- 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 authorities having jurisdiction. 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 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint

- device materials and installation.
- D. Use 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-inch and smaller.
 - F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2-inch and larger end connections.
 - G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
 - H. Install sprinkler piping with drains for complete system drainage.
 - 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 valves to drain piping between fire department connections and check valves. Drain to floor drain or to outside building.
 - K. Connect compressed-air supply to dry-pipe sprinkler piping.
 - L. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire-alarm devices, including low-pressure alarm.
 - M. Install alarm devices in piping systems.
 - N. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
 - O. 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-inch and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they are not subject to freezing.
 - P. Drain dry-pipe sprinkler piping.
 - Q. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices.
 - R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 00 "Standard Conditions for Fire Suppression."
 - S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 00 "Standard Conditions for Fire Suppression."
 - T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 00 "Standard Conditions for Fire Suppression."

3.03 JOINT CONSTRUCTION

- A. Joining method: Joints NPS 2-inch and smaller shall be threaded; Joints NPS 2-1/2-inch and larger shall be grooved mechanical joints.
- B. 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.
- C. Install unions adjacent to each valve in pipes NPS 2-inch and smaller.
- D. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2-inch and larger end connections.
- E. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- F. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- G. 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.
- H. 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.
- I. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- J. 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.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 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. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install dry-pipe and deluge valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, 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 sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
 - c. Install compressed-air-supply piping from building's compressed-air piping system.

3.05 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.

3.06 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 Electrical Specifications.

3.07 FIELD QUALITY CONTROL

- A. 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 sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 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.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.08 CLEANING

- A. Clean dirt and debris from sprinklers.
- 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.

3.09 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. Standard-pressure, dry-pipe sprinkler system, NPS 2-inch and smaller, shall be one of the following:
1. Standard-weight or Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight Schedule 40 or thin wall, galvanized-steel pipe with plain ends; plain-end-pipe fittings; and twist-locked joints.
 3. Standard-weight or 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.
- D. Standard-pressure, dry-pipe sprinkler system, NPS 2 ½-inch to NPS 6-inch shall be one of the following:
1. Standard-weight or Schedule 10, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight or Schedule 10, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.10 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Dry pendent, recessed, flush, and concealed sprinklers as indicated.
 - 3. Wall Mounting: Dry sidewall sprinklers.
 - 4. Spaces Subject to Freezing: Upright, dry pendent sprinklers; and dry sidewall sprinklers as indicated.
 - 5. Special Applications: Extended-coverage and quick-response sprinklers where indicated.
- B. 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. Upright 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.

END OF SECTION

SECTION 21 29 33 - CONTROLLERS FOR FIRE-PUMP DRIVERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Full-service, [full] [reduced] voltage controllers rated 600 V and less.
 - 2. Limited-service controllers rated 600 V and less.
 - 3. Controllers for diesel-drive fire pumps.
 - 4. Controllers for pressure-maintenance pumps.
 - 5. Remote alarm panels.

1.02 DEFINITIONS

- A. ATS: Automatic transfer switch(es).
- B. ECM: Electronic control module.
- C. MCCB: Molded-case circuit breaker.
- D. NO: Normally open.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of product indicated.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Enclosure types and details for types other than NEMA 250, Type 2.
 - c. Factory-installed devices.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of integrated unit.
 - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
 - g. Specified modifications.
 - 4. Include diagrams for power, signal, alarm, control wiring, and pressure-sensing tubing.

1.04 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Ambient Temperature Rating: Not less than 40 deg. F and not exceeding 122 deg. F unless otherwise indicated.
 - 2. Altitude Rating: Not exceeding 6600 feet unless otherwise indicated.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 20 and NFPA 70.
- B. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 21 05 48.13 "Vibration Controls for Fire Suppression Piping Equipment."
- C. Seismic Performance: Fire-pump controllers and alarm panels shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement>.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified [and the unit will be fully operational after the seismic event]."
- D. 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.

2.02 FULL-SERVICE CONTROLLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aquarius Fluid Products, Inc.
 - 2. ASCO Power Technologies, LP; a business of Emerson Network Power.
 - 3. Eaton.
 - 4. Hubbell Incorporated.
 - 5. Joslyn Clark Corporation.
 - 6. Master Control Systems, Inc.
 - 7. Metron Control Products div. Hubbell Industrial Controls.
 - 8. Tornatech.
- B. General Requirements for Full-Service Controllers:
 - 1. Comply with NFPA 20 and [UL 218] <Insert standard>.
 - 2. [Combined automatic and nonautomatic] [Nonautomatic] operation.
 - 3. Factory assembled, wired, and tested; continuous duty rated.
 - 4. Service entrance rated.
- C. Method of Starting:
 - 1. Pressure-switch actuated.
 - a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
 - b. System pressure recorder, electric ac driven, with spring backup.

- c. Programmable minimum-run-time relay to prevent short cycling.
 - d. Programmable timer for weekly tests.
 - 2. Magnetic Controller: Across-the-line type.
 - 3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.
- D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting Nonautomatic.
- E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.
- F. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.
- G. Door-Mounted Operator Interface and Controls:
 - 1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
 - 2. Method of Control and Indication:
 - a. [Microprocessor-based logic] <Insert logic type> controller, with multiline digital readout.
 - b. [Membrane] <Insert keypad type> keypad.
 - c. [LED] <Insert lamp type> alarm and status indicating lights.
 - 3. Local [and Remote] Alarm and Status Indications:
 - a. Controller power on.
 - b. Motor running condition.
 - c. Loss-of-line power.
 - d. Line-power phase reversal.
 - e. Line-power single-phase condition.
 - f. <Insert indication>.
 - 4. Audible alarm, with silence push button.
 - 5. Nonautomatic START and STOP push buttons or switches.
- H. Optional Features:
 - 1. Extra Output Contacts:
 - a. [One] <Insert number> NO contact(s) for motor running condition.
 - b. [One] <Insert number> set(s) of contacts for loss-of-line power.
 - c. [One] <Insert number> each, Form C contacts for high and low reservoir level.
 - d. <Insert contact type>.
 - 2. Local alarm bell.
 - 3. Door-mounted thermal or impact printer for alarm and status logs.
 - 4. Operator Interface Communications Ports: USB, Ethernet, and RS485.
- I. ATS:
 - 1. Complies with NFPA 20, [UL 218] <Insert standard>, and [UL 1008] <Insert standard>.
 - 2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
 - 3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
 - 4. Allows manual transfer from one source to the other.
 - 5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
 - 6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor

full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.

7. Local and Remote Alarm and Status Indications:
 - a. Normal source available.
 - b. Alternate source available.
 - c. In normal position.
 - d. In alternate position.
 - e. Isolating means open.
 - f. <Insert indication>.
8. Audible alarm, with silence push button.
9. Nonautomatic (manual, nonelectric) means of transfer.
10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.

2.03 LIMITED-SERVICE CONTROLLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Aquarius Fluid Products, Inc.
 2. ASCO Power Technologies, LP; a business of Emerson Network Power.
 3. Eaton.
 4. Hubbell Incorporated.
 5. Joslyn Clark Corporation.
 6. Master Control Systems, Inc.
 - a. Metron Control Products div. Hubbell Industrial Controls.
 7. Tornatech
- B. General Requirements for Limited-Service Controllers:
 1. Comply with NFPA 20 and [UL 218] <Insert standard>.
 2. [Combined automatic and nonautomatic] [Nonautomatic] operation.
 3. Factory assembled, wired, and tested; continuous duty rated.
- C. Method of Starting:
 1. [Pressure] [Nonpressure] switch actuated.
 - a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
 - b. System pressure recorder, electric ac driven, with spring backup.
 - c. Programmable minimum-run-time relay to prevent short cycling.
 - d. Programmable timer for weekly tests.
 2. The controller shall be of the combined manual and automatic, (across-the-line) (primary resistor) (part wind) (Wye-Delta) (limited service with running period timer)
 3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.
- D. Method of Stopping: [Automatic and nonautomatic shutdown after automatic starting] [Nonautomatic].
- E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.
- F. Method of Isolation and Overcurrent Protection: Inverse-time, nonadjustable MCCB, with an externally mounted operating handle.
- G. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
 2. Method of Control and Indication:
 - a. [Microprocessor-based logic] <Insert logic type> controller, with multiline [LCD] <Insert display type> digital readout.
 - b. [Membrane] <Insert keypad type> keypad.
 - c. [LED] <Insert lamp type> alarm and status indicating lights.
 3. Local [and Remote] Alarm and Status Indications:
- H. Controller power on.
- a. Motor running condition.
 - b. Loss-of-line power.
- I. Line-power phase reversal.
- a. Line-power single-phase condition.
 - b. <Insert indication>.
2. Audible alarm, with silence push button.
 3. Nonautomatic START and STOP push buttons.
 4. <Insert function>.
- J. Optional Features:
1. Extra Output Contacts:
 - a. [One] <Insert number> NO contact(s) for motor running condition.
 - b. [One] <Insert number> set(s) of contacts for loss-of-line power.
 - c. [One] <Insert number> each, Form C contacts for high and low reservoir level.
 - d. <Insert contact type>.
 2. Local alarm bell.
 3. Door-mounted thermal or impact printer for alarm and status logs.
 4. Operator Interface Communications Ports: USB, Ethernet, and RS485.
- K. ATS:
1. Complies with NFPA 20, [UL 218] <Insert standard>, and [UL 1008] <Insert standard>.
 2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
 3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
 4. Allows manual transfer from one source to the other.
 5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
 6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only, short-circuit overcurrent protection to comply with available fault currents.
 7. Local [and Remote] Alarm and Status Indications:
 - a. Normal source available.
 - b. Alternate source available.
 - c. In normal position.
 - d. In alternate position.
 - e. Isolating means open.
 - f. <Insert indication>.
 8. Audible alarm, with silence push button.
 9. Nonautomatic (manual, nonelectric) means of transfer.

10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.

2.04 STANDALONE ATS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Aquarius Fluid Products, Inc.
 2. Eaton.
- B. General Requirements for Standalone ATS:
 1. Complies with NFPA 20, [UL 218] <Insert standard>, and [UL 1008] <Insert standard>.
 2. Automatic and nonautomatic operation.
 3. Separate from controller and individually listed as a fire-pump-controller power transfer switch.
 4. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
 5. Allows manual transfer from one source to the other; factory assembled, wired, and tested.
- C. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at ATS location.
- D. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
- E. Door-Mounted Operator Interface and Controls:
 1. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
 2. Method of Control and Indication:
 - a. [Microprocessor-based logic] <Insert logic type> controller, with multiline [LCD] <Insert display type> readout.
 - b. [Membrane] <Insert keypad type> keypad.
 - c. [LED] <Insert lamp type> alarm and status indicating lights.
 3. Local [and Remote] Alarm and Status Indications:
 - a. Normal source available.
 - b. Alternate source available.
 - c. In normal position.
 - d. In alternate position.
 - e. Isolating means open.
 - f. <Insert indication>.
 4. Audible alarm, with silence push button.
 5. Nonautomatic (manual, nonelectric) means of transfer.
 6. Engine test push button.
 7. Start generator output contacts.
 8. Timer for weekly generator tests.
- F. Optional Features:
 1. Extra Output Contacts:
 - a. [One] <Insert number> each, Form A; isolating means open.
 - b. [One] <Insert number> each, Form C, in normal or alternate position.
 - c. <Insert contact type>.
 2. Door-mounted thermal or impact printer for alarm and status logs.
 3. Operator Interface Communications Ports: USB, Ethernet, and RS485.

2.05 CONTROLLERS FOR DIESEL-DRIVE FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aquarius Fluid Products, Inc.
 2. ASCO Power Technologies, LP; a business of Emerson Network Power.
 3. Eaton.
 4. Hubbell Incorporated.
 5. Joslyn Clark Corporation.
 6. Master Control Systems, Inc.
 7. Metron Control Products div. Hubbell Industrial Controls.
 8. Tornatech.
- B. General Requirements for Controllers:
1. Comply with NFPA 20 and [UL 218] <Insert standard>.
 2. [Combined automatic and nonautomatic] [Nonautomatic] operation.
 3. Factory assembled, wired, and tested.
- C. Method of Starting:
1. [Pressure] [Nonpressure]-switch actuated.
 - a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
 - b. System pressure recorder, electric ac driven, with spring backup.
 - c. Programmable minimum-run-time relay to prevent short cycling.
 - d. Programmable timer for weekly tests.
 2. Dual, redundant dc-voltage battery units, with automatic changeover.
 3. Emergency Control: Bypasses all automatic control circuits during manual starting and running.
 4. Automatic engine start on loss of ac power to the controller.
- D. Method of Stopping: [Automatic and nonautomatic shutdown after automatic starting] [Nonautomatic].
- E. Door-Mounted Operator Interface and Controls:
1. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
 2. Method of Control and Indication:
 - a. [Microprocessor-based logic] <Insert logic type> controller, with multiline [LCD] <Insert display type> readout.
 - b. [Membrane] <Insert keypad type> keypad.
 - c. [LED] <Insert lamp type> alarm and status indicating lights.
 3. Local [and Remote] Alarm and Status Indications:
 - a. Controller power on.
 - b. Engine-lubrication-system critically low oil pressure.
 - c. Engine-jacket coolant high temperature.
 - d. Engine fail-to-start.
 - e. Engine overspeed shutdown.
 - f. Low fuel level.
 - g. Missing or failed battery.
 - h. Battery charger failure.
 - i. System overpressure.
 - j. ECM selector switch in alternate ECM position.
 - k. Fuel injector malfunction.

4. Audible alarm.
 5. Nonautomatic START and STOP push buttons or switches.
 6. <Insert function>.
- F. Optional Features:
1. Extra Output Contacts:
 - a. [One] <Insert number> Form C contacts for low pump-room temperature.
 - b. [One] <Insert number> each, Form C contacts for high and low fuel levels.
 - c. [One] <Insert number> each, Form C contacts for high and low reservoir levels.
 2. Door-mounted thermal or impact printer for alarm and status logs.
 3. Operator Interface Communications Ports: USB, Ethernet, and RS485.
 4. Powered louver contacts.
 5. Powered engine-oil heater contacts.
 6. <Insert optional feature>.
- G. Battery Charger System:
1. Built-in, independent, dual battery chargers with automatic changeover; [12-V dc] [24-V dc] for [lead-acid] [nickel-cadmium] batteries.
 2. Standard: [UL 1236] <Insert standard>.

2.06 CONTROLLERS FOR PRESSURE-MAINTENANCE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aquarius Fluid Products, Inc.
 2. ASCO Power Technologies, LP; a business of Emerson Network Power.
 3. Eaton.
 4. Hubbell Incorporated.
 5. Joslyn Clark Corporation.
 6. Master Control Systems, Inc.
 7. Metron Control Products div. Hubbell Industrial Controls.
 8. Tornatech
- B. General Requirements for Pressure-Maintenance-Pump Controllers:
1. Type: UL 508, factory-assembled, -wired, and -tested, across-the-line controller; for combined automatic and manual operation.
 2. Enclosure: UL 508 and NEMA 250, Type 2 for wall-mounting.
 3. Factory assembled, wired, and tested.
 4. Finish: Manufacturer's standard color paint.
- C. Rate controller for scheduled horsepower and include the following:
1. Fusible disconnect switch.
 2. Pressure switch.
 3. Hand-off-auto selector switch.
 4. Pilot light.
 5. Running period timer.

2.07 REMOTE ALARM PANELS

- A. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested; and complying with NFPA 20 and [UL 218] <Insert standard>.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aquarius Fluid Products, Inc.

2. ASCO Power Technologies, LP; a business of Emerson Network Power.
 3. Eaton.
 4. Hubbell Incorporated.
 5. Joslyn Clark Corporation.
 6. Master Control Systems, Inc.
 7. Metron Control Products div. Hubbell Industrial Controls.
 8. Tornatech.
- C. Supervisory [and Normal] Control Voltage: [120-V ac] [240-V ac] <Insert voltage>; [single] [dual] source.
- D. Audible and Visual Alarm and Status Indications:
1. Driver running.
 2. Loss of phase.
 3. Phase reversal.
 4. Supervised power on.
 5. [Common] [Separate] trouble on the controller.
 - a. <Insert alarm>.
 6. Controller connected to alternate power source.
- E. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights; [push-to-test] [non-push-to-test, with separate test push button].
1. Engine running.
 2. Controller main switch turned to the off or manual position.
 3. Supervised power on.
 4. [Common] [Separate] trouble on the controller or engine.
 - a. <Insert alarm>.
 5. Common pump room trouble.
 6. Controller connected to alternate power source.
 7. <Insert indication>.
- F. Audible alarm, with silence push button.
- G. Pump REMOTE START push button.

2.08 ENCLOSURES

- A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
1. Indoor, Dry and Clean Locations: [Type 1 (IEC IP10)] <Insert type>.
 2. Indoor Locations Subject to Dripping Noncorrosive Liquids: [Type 2 (IEC IP11)] <Insert type>.
 3. Outdoor Locations: [Type 3R (IEC IP14)] [Type 4 (IEC IP56)] [Type 4X (IEC IP56)] <Insert type>.
 4. Other Wet or Damp, Indoor Locations: [Type 4 (IEC IP56)] [Type 4X (IEC IP56)] <Insert type>.
 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).
- B. Enclosure Color: [Manufacturer's standard "fire-pump-controller red"] <Insert color>.
- C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
- D. Optional Features:
1. Floor stands, 12 inches high, for floor-mounted controllers.
 2. Space heater, [120-V ac] [240-V ac] [, with humidistat] [, with thermostat].
 3. Tropicalization.
 4. <Insert optional feature>.

2.09 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and [UL 218] <Insert standard>.
 - 1. Verification of Performance: Rate controllers according to operation of functions and features specified.
- B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION**3.01 CONTROLLER INSTALLATION**

- A. Coordinate installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Install controllers within sight of their respective drivers.
- D. Connect controllers to their dedicated pressure-sensing lines.
- E. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches above finished floor, and bottom of enclosure not less than 12 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall.
- F. Floor-Mounting Controllers: Install controllers on concrete base(s), using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Architectural Specifications.
 - 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.
- G. Seismic Bracing: Comply with requirements specified in Section 21 05 48.13 Vibration Controls for Fire Suppression Piping and Equipment.
- H. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- I. Comply with NEMA ICS 15.

3.02 STANDALONE ATS INSTALLATION

- A. Wall-Mounting ATS: Install ATS on walls with disconnect operating handles not higher than 79 inches above finished floor, and bottom of enclosure not less than 12 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Floor-Mounting ATS: Install ATS on concrete bases, using floor stands high enough so that

the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Architectural Specifications.

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.
- C. Seismic Bracing: Comply with requirements specified in Section 21 05 48.13 Vibration Controls for Fire Suppression Piping and Equipment.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.03 REMOTE ALARM PANEL INSTALLATION

- A. Install panels on walls with tops not higher than [72 inches <Insert height> above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall.

3.04 POWER WIRING INSTALLATION

- A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Electrical Specifications.

3.05 CONTROL AND ALARM WIRING INSTALLATION

- A. Install wiring between controllers and remote devices [and facility's central monitoring system]. Comply with requirements in NFPA 20, NFPA 70, and Electrical Specifications.
- B. Install wiring between remote alarm panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Electrical Specifications.
- C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Electrical Specifications.
- D. Bundle, train, and support wiring in enclosures.
- E. Connect remote manual and automatic activation devices where applicable.

3.06 IDENTIFICATION

- A. Comply with requirements in NFPA 20 for marking fire-pump controllers.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and Electrical Specifications.

3.07 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
- B. Acceptance Testing Preparation:
1. Inspect and Test Each Component:
 - a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
 - b. Test insulation resistance for each element, component, connecting supply,

- feeder, and control circuits.
- c. Test continuity of each circuit.
- 2. Verify and Test Each Electric-Drive Controller:
 - a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify [Architect] [Construction Manager] [Owner] before starting the motor(s).
 - b. Test each motor for proper phase rotation.
- 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
- 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Field Acceptance Tests:
 - 1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to [Architect] [Construction Manager] [Owner] and authorities having jurisdiction.
 - 2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
 - 3. Engage manufacturer's factory-authorized service representative to be present during the testing.
 - 4. Perform field acceptance tests as outlined in NFPA 20.
- D. Controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.08 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. <Insert startup steps if any>.

3.09 ADJUSTING

- A. Adjust controllers [and battery charger systems] to function smoothly and as recommended by manufacturer.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
- C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- D. Set field-adjustable pressure switches.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain controllers and remote alarm panels.

END OF SECTION

SECTION 21 32 13 - ELECTRIC-DRIVE, VERTICAL-TURBINE FIRE PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes vertical-turbine fire pumps, accessories, and specialties:

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
- B. Product Certificates: For each type of fire pump, from manufacturer.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Comply with NFPA 20.
- B. Seismic Performance: Fire pumps 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."
 - 2. Component Importance Factor: 1.5.
- C. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.
- D. 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.

2.02 ASSEMBLY DESCRIPTION

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
- C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.03 VERTICAL-TURBINE FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Patterson Pump Company; a Gorman-Rupp company.
 - 2. Peerless Pump Company.
 - 3. Aurora Pump.
 - 4. S.A. Armstrong Limited.
- B. Pump Head: Cast iron, for surface discharge.
 - 1. Discharge Outlet: Flanged with flanges complying with ASME B16.1; except connections may be threaded according to ASME B1.20.1, in sizes where flanges are not available.
 - 2. Pump Head Seal: Stuffing box and packing.
 - 3. Base: Cast iron or steel with hole for electrical cable.
- C. Pump:
 - 1. Standard: UL 448, for vertical-turbine pumps for fire service.
 - 2. Discharge Head: High profile, with flange above ground outlet Class 125 for cast iron, and with flange above ground outlet Class 150 for steel, with 0.5-inch NPT pressure gauge connection.
 - 3. Stuffing Box: Cast iron with packing rings, pressure-relief connection, stainless-steel packing gland, bronze bearing, and rubber slinger.
 - 4. Line Shaft: Stainless steel in sections 10 feet or less, with left-hand threaded steel couplings, centering spiders, and fluted rubber bearings.
 - 5. Line Shaft Bearings: Bronze, water lubricated.
 - 6. Bowl Section: Multiple close-grained, flanged cast-iron bowls. Intermediate bowls have enamel-lined waterways for maximum efficiency and wear protection, and they are of identical design for interchangeability. Bowls are fitted with bronze neoprene bearings.
 - 7. Impeller: Closed type, silicon bronze or stainless steel, dynamically balanced, and securely fastened to the bowl.
 - 8. Suction Bell: Close-grained cast-iron bowl with bronze bearing and bronze sand collar.
 - 9. Wear Rings: Bronze located in the suction and intermediate bowls and with minimum clearance to the surface of the impeller.
 - 10. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded sleeve couplings or rabbet fit flange ends in sections of 10 feet or less.
 - 11. Suction Strainer: Cast or fabricated; bronze, stainless steel, or Monel; and sized to restrict passage of 0.5-inch diameter objects.
- D. Driver:
 - 1. Standard: UL 1004A.
 - 2. Type: Electric motor; NEMA MG 1, polyphase Design B.
 - 3. Mounting: On pump head above pump.
- E. Capacities and Characteristics: (Specifier to Provide)

1. Rated Capacity:
2. Total Rated Head:
3. Inlet Column Size:
4. Pump Column Length
5. Pump Head Outlet Flange:
6. Suction Head Available at Pump:
7. Motor Horsepower:
8. Motor Speed:
9. Electrical Characteristics:
 - a. Volts:
 - b. Phase: Three.
 - c. Hertz: 60.
 - d. Full-Load Amperes:
 - e. Minimum Circuit Ampacity:
 - f. Maximum Overcurrent Protection
10. Pump-Start, Pressure-Switch Setting:
11. Pump-Stop, Pressure-Switch Setting:

2.04 FIRE PUMP ACCESSORIES AND SPECIALTIES

- A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump discharge piping.
- B. Relief Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CLA-VAL Automatic Control Valves.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
 2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
- C. Outlet Fitting: Concentric tapered reducer at pump-head discharge outlet.
- D. Discharge Cone: Closed or open
- E. Hose Valve Manifold Assembly:
 1. Standard: Comply with requirements in NFPA 20.
 2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel, with ends threaded according to ASME B1.20.1.
 3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
 4. Automatic Drain Valve: UL 1726.
 5. Manifold:
 - a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
 - b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
 - c. Escutcheon Plate: Brass or bronze; round.
 - d. Exposed Parts Finish: Polished Rough brass, chrome plated.
 - e. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.05 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink and recommended for interior and exterior applications.

- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.06 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
 - 1. Verification of Performance: Rate fire pumps according to UL 448.
- B. Fire pumps will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting:
 - 1. Install fire pumps on cast-in-place concrete equipment bases.
- C. Install fire-pump discharge piping equal to or larger than size required by NFPA 20.
- D. Support piping and pumps separately, so weight of piping does not rest on pumps.
- E. Install valves that are same size as connecting piping.
- F. Install pressure gage on pump-head discharge flange pressure-gage tapping.
- G. Install piping hangers and supports, anchors, valves, gages, and equipment support according to NFPA 20.
- H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.02 ALIGNMENT

- A. Align pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connection.
- D. Align pump and driver shafts for angular and parallel alignment according to HI 2.4 and to tolerances specified by manufacturer.
- E. Install piping adjacent to pumps and equipment to allow service and maintenance.
- F. Connect relief-valve discharge to drainage piping or point of discharge.
- G. Connect fire pumps to their controllers.
- H. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.03 FIELD QUALITY CONTROL

- A. Test each fire pump with its controller as a unit.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
 - 2. Test according to NFPA 20 for acceptance and performance testing.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.04 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION

SECTION 21 34 00 - PRESSURE-MAINTENANCE PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Regenerative-turbine, pressure-maintenance pumps.
 - 2. Vertical turbine, pressure-maintenance pumps.
- B. Related Requirements:
 - 1. Section 212933 "Controllers for Fire-Pump Drivers" for pressure-maintenance-pump controllers.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For pumps, accessories, and specialties.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 VERTICAL-TURBINE, PRESSURE-MAINTENANCE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aurora Pump; Pentair Ltd.
 - 2. Patterson Pump Company; a Gorman-Rupp company.
 - 3. Peerless Pump Company.
 - 4. S.A. Armstrong Limited.
- B. Description: Factory-assembled and -tested, vertical, multistage, open-line-shaft turbine pump as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted above pump head.
- C. Pump Construction:
 - 1. Pump Head: Cast iron, for surface discharge, with flange except connections may be

- threaded in sizes in which flanges are not available.
- 2. Pump Head Seal: Stuffing box and stuffing.
- 3. Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
- 4. Line Shaft Bearings: Rubber sleeve, water lubricated.
- 5. Line Shaft: Steel.
- 6. Line Shaft Bearings: Corrosion resistant, oil lubricated.
- 7. Impeller Shaft: Monel metal or stainless steel.
- 8. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
- 9. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet or less, with strainer of cast or fabricated bronze or stainless steel at bottom.
- D. 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.
- E. Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Section 210513 "Common Motor Requirements for Fire Suppression Equipment."
 - 1. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet long.
- F. Base: Cast iron or steel with hole for electrical cable.
- G. Nameplate: Permanently attached to pump and indicating capacity and characteristics.
- H. Capacities and Characteristics: (Specifier to Provide)
 - 1. Rated Capacity:
 - 2. Total Dynamic Head:
 - 3. Working Pressure:
 - 4. Inlet Column Size:
 - 5. Pump Column Length:
 - 6. Outlet Size:
 - 7. Flange:
 - 8. Suction Head Available at Pump:
 - 9. Motor Horsepower:
 - 10. Motor Speed:
 - 11. Electrical Characteristics:
 - a. Volts:
 - b. Phases:
 - c. Hertz:
 - d. Full-Load Amperes:
 - e. Minimum Circuit Ampacity:
 - f. Maximum Overcurrent Protection:
 - 12. Pump-Start, Pressure-Switch Setting:
 - 13. Pump-Stop, Pressure-Switch Setting:

2.02 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 210513 "Common Motor Requirements for Fire Suppression 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.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.
- B. Equipment Mounting:
 - 1. Install regenerative-turbine, pressure-maintenance pumps according to HI 1.4.
 - 2. Install vertical-turbine, pressure-maintenance pumps according to HI 2.4.
 - 3. Install base-mounted pumps on cast-in-place concrete equipment base(s).
 - a. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - b. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - d. Attach pumps to equipment base using anchor bolts.
 - e. Shim pumps as needed to make them level.
 - 4. Install isolation valves in both inlet and outlet pipes near the pump.

3.02 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.
- B. Prepare test and inspection reports.

3.03 ADJUSTING

- A. Lubricate pumps as recommended by manufacturer.
- B. Set field-adjustable pressure-switch ranges as indicated.

END OF SECTION

DIVISION 22 - PLUMBING

SECTION 22 05 00 - STANDARD CONDITIONS FOR PLUMBING

PART 1 - GENERAL

1.01 REFERENCE

- A. Requirements established within the portions of this project manual titled Division 1, General Requirements are collectively applicable to the work of this section.
- B. Instructions to Bidders, Special Conditions and addenda as issued are part of this specification.
- C. Plumbing drawings along with all other project drawings and specifications represent the work of this section.
- D. Drawings, Contract, General Conditions and Supplementary Conditions form a part of this section, by reference thereto and shall have the same force and effect as if printed herewith in full. Failure to review these sections shall not relieve the Contractor of his responsibility to fully comply with the terms therein.

1.02 SCOPE

- A. Provide labor, material, equipment and supervision necessary to install complete operating plumbing systems as indicated on the drawings and specified herein, including all work at the site and within the proposed construction areas to accomplish the required work.
- B. It shall be the contractor's responsibility to coordinate his work and the work of his subcontractors to ensure that all the work is covered. He shall designate who is responsible for various portions of work which may overlap so that there is complete coverage of all required work. It is the position of the owner and the A/E that all work is the responsibility of the mechanical contractor within this division of the work.
- C. The plumbing contractor shall remove the entire existing plumbing system including fixtures, domestic water piping, soil, waste and vent piping, gas piping, rainwater conductors, hangers, supports and floor drains. Pipe, conduit, ductwork, and wiring shall be cut back behind wall surfaces, above ceilings, and below floor levels so that a patch can be placed over the opening.
- D. All work shown on the drawings and not expressly mentioned in the specifications and all work specified but not shown on the drawings, but necessary for the proper execution of same shall be performed by the contractor. It is not the intent of the drawings and specifications to describe every feature and detail of the work.
- E. No additions to the contract amount will be approved for any materials, equipment, or labor to perform additional work unless it can be clearly shown to be beyond the scope and intent of the drawings and specifications.
- F. Plumbing contractor's scope of work shall include but not be limited to the following:
 - 1. Domestic water system and insulation (See Section 22 11 16, 22 07 00 and 22 40 00).
 - 2. Sanitary and vent system. (See Section 22 13 00)
 - 3. Storm and overflow systems and any insulation (See Section 22 07 00 and 22 13 00).

4. Domestic water piping serving humidifiers.
5. Fuel gas piping.
6. All other work in Division 22.
7. Roof penetrations for plumbing work.
8. Demolition of existing work to accommodate new work.
9. Repair existing areas affected by new construction. Patch, repair and finish to match existing.
10. Provide third party certification of all packaged systems by a Nationally Recognized Testing Laboratory (NRTL) in accordance with OSHA Federal Regulations 29CFR1910.303 and .399 as well as Pamphlet #70 and National Electrical Code Article 90-7.
11. Refer to Commissioning of Systems Specification for additional work and participation.
12. Fire stopping of penetrations. (See Section 22 05 50).

1.03 REGULATIONS, CODES, AND STANDARDS

- A. Work shall be performed in accordance with the latest adopted codes, amendments, regulations, and ordinances of the authorities having jurisdiction. Observe all safety regulations including the requirements of OSHA.
- B. Obtain and pay for all permits, connection charges, inspections, and certificates required to complete the work.
- C. Latest editions of any referenced standards shall govern.
- D. Contractor shall arrange and pay for all tests and inspections specified herein or required by above agencies and furnish required certificate of inspection to owner.
- E. Where the contract documents are more stringent but not in conflict with the applicable codes, the more stringent requirements shall be followed.

1.04 SUBMISSIONS

- A. The procedure for submissions of shop drawings shall be as specified in Division 1, or as a minimum, as indicated below.
- B. Furnish submissions of shop drawings and samples of materials and equipment as indicated in these sections, on the drawings, or as directed by the A/E. Submissions will be made in a timely fashion such that adequate time exists to review the drawings, or material, and arrive at the site in accordance with the project schedule.
- C. Submissions will not be accepted with work defined as "By Others". Identify contractor by name and with his approval so indicated. Submissions are required prior to purchasing, fabrication, or installation of any material or equipment. Submissions shall be reviewed and certified by the submitting contractor that they are in accordance with the project documents.
- D. When requested by the engineer, shop drawings shall be required to be submitted to designated agencies for review and approval prior to submission to the engineer.
- E. Contractor shall arrange and pay for all tests and inspections specified herein or required by above agencies and furnish required certificate of inspection to owner.
- F. Contractor to forward a copy of submittals which have electrical requirements to the Electrical Contractor (EC) for coordination of voltage, amperage, and phase. Response to be received from EC prior to ordering of equipment by mechanical contractor.
- G. Submissions shall include warranties by the manufacturer for equipment being provided. Submissions for commonly related items such as fixtures, trim, carriers, drains shall be combined in a single brochure with all items being furnished clearly identified.
- H. Shop drawings and submittals shall be checked and stamped by the contractor before

- submitting. They shall conform to measurements made at the site, the contract requirements, and coordinated with all other trades.
- I. Specific models in catalog sheets must be identified as well as all options, voltages, phases, etc. identified so as to be clear on what is being provided.
 - J. Contractor and manufacturers shall be responsible for all physical characteristics of the equipment and field verify with final locations, coordinate with floor plans, confirm service access, clearances, confirm equipment arrangements, electrical disconnect clearances, and pathways/travel/access to the final equipment installation locations. Submission of equipment shop drawing will be deemed evidence of compliance with this requirement. If no shop drawing is submitted, contractor shall be fully responsible for a complete installation and assumes all related costs that affects the contractor and other trades.
 - K. To aid in the preparation of submittals or shop drawings, the engineer can provide the electronic files for use by the contractor. The electronic files will be provided upon execution of the engineer's electronic file release contract prepared specifically for this project. The electronic files will be released in the format used by the architect and engineer to design the project. If this file format is not compatible with the contractor's needs, additional charges for providing the changes to the requested file format may be necessary at \$175/hr. billable to the contractor.
 - L. Model numbers – It is the contractor's responsibility to confirm the latest model numbers at the time of bid. The model number indicated on the drawings are for reference. No additional costs will be accepted if the manufacturer has updated the model number during or after the design process thru to the point of shop drawing issuance. The performance and capacity indicated in the schedules on the drawings take precedent over the model number.

1.05 SITE INSPECTION

- A. Visit site, inspect, and become aware of all conditions which may affect the work. Investigate utilities, protection requirements for adjacent facilities, storage locations, and access to the construction area.
- B. Submission of bid will be deemed evidence of having complied with this request. Contractor may not request additional costs for existing conditions which were evident from inspection of the site.

1.06 SUBSTITUTIONS

- A. Material and equipment specified shall be deemed as that which the bidder's quotation represents the contractor.
- B. Once bids are accepted only that material and equipment listed in the specifications or added by addenda shall be acceptable. Substitution information for inclusion in an addenda must be received by the A/E at least 10 days prior to bid opening. If acceptable, an addenda will be issued which will add the additional acceptable manufacturers or materials and be available for all contractors to consider. It shall be a basic premise that a contractor is a lowest bidder because he utilized substituted materials or equipment as opposed to specified materials or equipment.
- C. If the contractor submits alternate equipment, manufacturers, systems, methods, or materials, not specifically identified in the specifications, additional review and investigation time may be required by the engineer. If the engineer determines additional review time is required because of the substitution, then this will be a billable service by the engineer at the rate of \$175.00/hr. for such services. Also, billable will be any redesign time and revisions to drawings should they be necessary for incorporation into the work. Services will be billable to the contractor making such substitutions and will be payable prior to approval or

rejection.

- D. Contractor and manufacturers shall be responsible for all physical characteristics of the equipment and field verify with final locations, coordinate with floor plans, confirm service access, clearances, confirm equipment arrangements, electrical disconnect clearances, and pathways/travel/access to the final equipment installation locations. Submission of equipment shop drawing will be deemed evidence of compliance with this requirement. If no shop drawing is submitted, contractor shall be fully responsible for a complete installation and assumes all related costs that affects the contractor and other trades.

1.07 DRAWINGS AND SPECIFICATIONS

- A. The drawings are generally diagrammatic and necessary field coordination and adjustment must be provided by the contractor prior to installation. Such deviations to the work to allow for coordination shall be kept to a minimum and any such deviations shall be at no extra cost.
- B. When a conflict or contradiction exists either between drawings and specs or between specs or between different drawings or details, the more stringent shall apply.
- C. Drawings and specifications are intended to be taken as a whole and each is to supplement the other. It is not intended that all work must be both shown on drawings and specified in the specifications.
- D. An item shown on the drawings and not indicated in the specifications is to be understood to be required for the project. An item specified and not shown on the drawings is to be understood to be required for the project.
- E. The architects or engineer's interpretation of the documents shall be binding upon the contractor. If a question arises, the contractor shall ask for an interpretation prior to bidding and an answer shall be issued as an addendum to all bidders.
- F. If a question arises after bidding the A/E interpretation shall govern.

1.08 MEASUREMENTS

- A. Before ordering materials or commencing with any work, the contractor shall verify all measurements at the building. Coordination of equipment, materials, spaces, and dimensions are the responsibility of the contractor.

1.09 PROGRESS SCHEDULE

- A. Provide a project schedule which shall show start, sequence of each type of work, milestone schedule, and completion of each type of work, with overall completion date.

1.10 COST SCHEDULE

- A. Provide a detailed cost breakdown indicating labor and material amounts for various types of work.
- B. AIA forms are required for this submission.

1.11 COMPLETION

- A. The contractor shall deliver to the owner, with his request for final payment, copies of all manufacturer's guarantees, equipment instructional manuals, a complete set of all final shop drawings, catalog cuts, service contracts, and other items as may be required elsewhere in the documents.

1.12 OFFICE

- A. The contractor shall set up his job office (desk) where directed by the owner.

1.13 STORAGE

- A. Material shall be stored only where directed by the owner.

1.14 SANITARY

- A. The contractor will at his own expense, provide and maintain in a sanitary condition, a portable chemical toilet.
- B. Toilet will be located where directed by the owner.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All material shall be new and of present day manufacture.
- B. All material and equipment shall be in conformance with accepted trade standards.
- C. Whenever equipment or material is referred to in the singular, such as "the fan", it shall be deemed to apply to as many such items as may be necessary to complete the installation.
- D. The word "provide" means "furnish and install complete, tested, and adjusted as necessary with all accessories, covers, escutcheons". The word "piping" means pipe, fitting, controls, valves and hangers as required for a complete system.

2.02 MOTORS

- A. Incorporate latest IEEE and NEMA standards.
- B. All copper windings with ball bearings.
- C. Indoors; drip proof, 40 degree C rise.
- D. Outdoors; totally enclosed 55 degree C rise.
- E. Motors over 10 HP to be high efficiency with PF in excess of 0.9.

2.03 MOTOR STARTERS AND CONTACTORS

- A. Fractional with horsepower up to ½ HP; electrical contract.
- B. Polyphase and single phase above ½ HP: this contract.
- C. Electrical contractor shall install all starters except for those provided as an integral part of equipment.
- D. Polyphase starters shall be magnetic combination type, across-the-line electrically operated, electrically held, three pole assemblies, with arc extinguishing characteristics, silver to silver renewable contacts, 3 pole thermal bi-metallic, red run pilot light, individual phase protection, with overload heaters matched to motors installed and with 4 auxiliary contact, Hand-off-Auto switch, and control transformer.
- E. For single phase motors above ½ HP provide magnetic combination single phase motor starters with overloads, non-fusible disconnect switch, red run pilot light, integral 120 volt

- control transformer with dual primary fusing auxiliary contacts.
- F. Starters shall be as manufactured by G. E., Siemens, Square "D" or Cutler-Hammer.

2.04 EQUIPMENT START UP

- A. Verify that equipment is operating within warranty requirements.
- B. Advise owner and A/E at least two days prior.
- C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to A/E.

2.05 LUBRICATION

- A. Lubricate all equipment in accordance with manufacturer's instructions.
- B. Lubricate prior to start up.
- C. Provide one years' supply of lubricants to the owner.

2.06 OPERATING INSTRUCTIONS AND MANUALS

- A. Properly and fully instruct owner's personnel in the operation and maintenance of all systems and equipment.
- B. Ensure that the owner's personnel are familiar with all operations to carry on required activities.
- C. Such instruction shall be for each item of equipment and each system as a whole.
- D. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, wiring diagrams, control sequences, service requirements, piping diagrams, names and addresses of vendors, suppliers and emergency contacts. Three manuals shall be provided.
- E. Provide to the owner any special tools necessary to operate any of the equipment.

2.07 DRAIN PANS

- A. All water heaters mounted above the floor shall be provided with drain pans. Drain to suitable discharge point acceptable to owner and A/E. To be visible outfall.
- B. Drains shall slope down in direction of flow at 1" per 10 feet.

PART 3 - EXECUTION

3.01 PROTECTION

- A. Plug or cap open ends of piping systems and conduit.
- B. Stored materials shall be covered to prevent damage by inclement weather, sun, dust, or moisture.
- C. Protect all installed work until accepted in place by the owner. Cover plumbing fixtures.
- D. Do not install plates, polished metal escutcheons, and other finished devices until masonry, tile, and painting operations are complete or protect otherwise.
- E. Protect all existing or new work from operations which may cause damage such as hauling, welding, soldering, painting, insulating, and covering.

3.02 WORKMANSHIP

- A. Install all work neat, trim, and plumb with building lines.
- B. Install work in spaces allocated.
- C. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.

3.03 EXCAVATION, SHORING, PUMPING, BACKFILLING

- A. Perform all excavation required to install the work. Deposit excavated material so as not to create a slide hazard.
- B. No work shall be placed on rock. Cushion with 6 " layer of crushed stone.
- C. Protect tree roots with burlap covering and maintain moist until backfilled.
- D. Base estimates on excavation which will include earth, sand, clay, rubbish, debris, and all other materials up to one cubic yard in size. Boulders or rock larger than one cubic yard which need to be broken up with pneumatic equipment or explosives will be separately negotiated at the time of discovery with the owner and A/E. Do not proceed with rock excavation until an agreement is reached.
- E. Maintain excavations free of water.
- F. Shore excavations to prevent cave-in in accordance with OSHA regulations and to prevent strains on work put in place until ready to receive backfill.
- G. Backfill with clean material and pneumatically tamp in 8" layers. Remove excess material, including rock, from site or as directed by the A/E.
- H. Backfill piping trenches within 18" of footings, columns, piers, or grade beams, with concrete. Protect piping from direct contact and adherence to concrete.
- I. Return to original condition any areas disturbed for excavation.

3.04 FASTENERS, HANGERS, AND SUPPORTS

- A. Furnish and install all hangers and supports required to suspend, mount, or hang the work.
- B. Furnish and install all miscellaneous steel angles, channels, beams, clips, brackets, and anchors to hang or support the work. Provide submissions for review.
- C. Install concrete inserts before concrete is poured.
- D. Drilled inserts shall not be loaded to more than 1/4 rated capacity with a minimum of 200 lbs.
- E. Powder driven fasteners shall not be allowed for piping larger than 2", or for equipment. When used they shall not be loaded more than 1/8 rated capacity with a minimum of 200 lbs.
- F. All hangers, miscellaneous steel, braces, and supports shall be galvanized, cadmium plated, or painted with corrosion resistant primer and finish coat of epoxy enamel.
- G. Piping shall be supported from adjustable clevis type hangers with insulation pipe saddles at not more than 8 foot centers up to 1 1/4" dia. and 10 foot centers above 1 1/4" dia. Piping shall not support other piping.
- H. Support vertical piping at floor levels. Piping shall have split rings.
- I. Provide and install lintels where required for mechanical work and not indicated on architectural or structural drawings.
- J. Furnish steel framing for roof openings and floor openings. Submit details for review.

3.05 SLEEVES

- A. All piping passing through floors or walls shall have sleeves unless holes are cored. Sleeves shall be 16 gage galvanized steel in non-bearing walls, 10 gage galvanized steel for bearing walls, and schedule 40 galvanized pipe in floors. Sleeves shall accommodate

insulation. This shall not apply to sprinkler piping.

- B. Sleeves passing through foundation walls not exposed to interior spaces or sleeves passing through slab on grade may be schedule 40 PVC.
- C. Wall sleeves shall finish flush with wall.
- D. Floor sleeves shall extend 1 inch above floor.
- E. Sleeves in walls between interior spaces and unexcavated, exterior, crawl, or backfilled spaces shall be made watertight with "Link-Seal" modular wall and casing seal. Casing shall be schedule 40 galvanized pipe with anchor flange.

3.06 PLATES

- A. Furnish and install chrome plated plates wherever piping passes into finished areas.
- B. Plates shall be securely fastened to piping or building construction.
- C. Floor plates shall cover one inch floor extension.

3.07 OFFSETS, TRANSITIONS, MODIFICATIONS

- A. Furnish and install all offsets necessary to install the work and to provide clearance for the other trades.
- B. Maintain adequate headroom and clearance as directed by the A/E.
- C. Ductwork transitions necessary to accommodate available space or clearance requirements shall be contract requirements.
- D. Incidental modifications necessary to the installation of the systems shall be made as necessary and at the direction of the A/E.
- E. Rises and drops of piping systems shall be provided as required and where directed to allow for clearances to other construction. Drains shall be installed at no additional cost to the owner. The contractor shall allow for such occurrences in his bid.
- F. Piping and equipment shall be so arranged as to not pass in front of windows, doors, access panels, access doors, coil removal or filter removal space or service clearance areas. Do not install within 3'-0" clearance of electrical panel fronts.

3.08 RECESSES

- A. Furnish information to the general contractor as to sizes and locations of recesses required to install panels, boxes, grilles, and other equipment or devices which are to be recessed into walls.
- B. Make offsets or modifications as required to suit final locations.

3.09 EQUIPMENT SETTING

- A. Furnish and install as a minimum, a 4" thick concrete pad beneath all floor mounted equipment in mechanical rooms, boiler rooms, or equipment rooms, or outside on grade. This shall not apply to residential installations of water heaters unless detailed on drawings or specified elsewhere.
- B. Furnish and install as a minimum, spring vibration isolators under any equipment 5 HP and over and rubber-in-shear vibration isolation under all equipment less than 5 HP. This shall apply to residential installations.
- C. Reinforce concrete with No. 4 rods 12" on centers both ways.
- D. Pad to have 3/4" dowels into concrete at 1 per 4 square feet.

3.10 LABELING

- A. All equipment shall be provided with permanent black laminated white core labels with 3/8" letters.

3.11 FLASHING AND COUNTER-FLASHING

- A. Roof drains and overflow drains shall have counter-flashing fittings. General contractor shall provide flashing.
- B. Piping and conduit through the roof shall be flashed by the General Contractor. This contractor shall furnish counterflashing.

3.12 ACCESS

- A. Locate all equipment, valves, devices and controllers which may need service in accessible places.
- B. Where access is not available; access panels shall be provided. Furnish prime painted steel access doors to the General Contractor for installation.
- C. Access doors shall be 16 gauge frames and 22 gauge steel door. Access doors in fire rated walls shall have a "B" label for 1 ½ hours.
- D. Maintain clearances for tube removal, coil pulls, and filter removal.

3.13 WIRING

- A. Power wiring shall be provided by the Division 26 Electrical Contractor. This contractor shall furnish all 3 phase starters, pushbuttons, and controllers necessary to operate the equipment. The Electrical Contractor shall store and install the electrical devices and furnish and install the power wiring.
- B. Control wiring shall be furnished and installed under Division 26 portion of the work. Wiring for controls is control wiring whether it is line voltage or low voltage.
- C. All wiring shall be in accordance with the NEC.
- D. Pushbuttons shall be maintain-contact type.
- E. Refer to the electrical specifications for wiring methods.
- F. Plenum rated cable is required for control wiring.

3.14 UTILITIES

- A. Refer to Division 1 for requirements for providing temporary utilities.

3.15 CUTTING AND PATCHING EXTERIOR SERVICES

- A. This contractor shall be responsible for returning disturbed areas to original condition where excavation for utilities has been required.
- B. Cut and patch paved areas to match original surfaces.
- C. Properly tamp backfill before finishing surfaces.
- D. Concrete pavements and curbs shall be formed and poured to match adjacent areas.
- E. Grass areas shall be sodded and maintained until established growth is achieved.

3.16 GUARANTEE

- A. All work shall be guaranteed to be free from defects for a period of one year of operation from date of acceptance by the owner unless otherwise specified. Material and labor for

first year warranty is to be provided.

- B. Guarantee shall be extended for all non-operational periods due to failure within the guarantee period.

3.17 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver material and equipment in manufacturer's original cartons or on skids.
- B. Store material in dry enclosures or under protective coverings out of way of work progress.
- C. Handle so as to prevent damage to product or any surrounding material.

3.18 MANUFACTURERS' NAMES

- A. Manufacturers' names are included herein to establish those suppliers who may provide products for this project subject to the requirements of the specifications. Although a manufacturer's name may appear as an acceptable supplier it is not understood that a standard product is acceptable. Products must also meet the technical, performance, and physical requirements of the project as well as being named in the specification. Any deviations from this must be acknowledged at bid time by the supplier and he shall be solely responsible for any and all costs associated with the application of his product in the project.
- B. A design cannot be prepared which accommodates the installation of all suppliers and is not intended to do so. If certain modifications must be made to accommodate one particular supplier's equipment it shall be considered the contractor's responsibility to arrange for such accommodations and be financially responsible for same.

3.19 AS-BUILT DRAWINGS

Specifier: Verify if As-Built need to be on CAD in addition to drawings.

- A. At the completion of the work the contractor shall furnish a reproducible as-built drawings to the A/E for approval. The drawings shall indicate all work installed and its actual size and location. If acceptable, the A/E will submit the as-built drawings to the owner as record drawings. If not acceptable, the A/E will return the drawing to the contractor to make corrections as required. The contractor will resubmit for approval.
- B. The as-built drawings shall indicate measured dimensions of underground lines and other concealed work.
- C. To aid in the preparation of as-built drawings, the engineer can provide the electronic files for use by the contractor. The electronic files will be provided upon execution of the engineer's electronic file release contract prepared specifically for this project. The electronic files will be released in the format used by the architect and engineer to design the project. If this file format is not compatible with the contractor's needs, additional charges for providing the changes to the requested file format may be necessary at \$175/hr. billable to the contractor.

3.20 PENETRATION SEALING

- A. All penetrations of fire walls, smoke walls, and floors by pipes or wiring shall be sealed to prevent the flow of gasses or smoke.
- B. The sealant shall be foamed in place between the penetrant and the adjacent floor or wall with DOW Corning RTV foam or equivalent by 3M, Hilti, or Chase foam.
- C. The installation shall meet the approval of the authority having jurisdiction.
- D. Penetrations through rated surfaces shall have a UL rating equivalent to the adjacent surfaces.

3.21 CUTTING AND PATCHING INTERIOR SURFACES

- A. Respective contractor shall install all hangers, supports, pipe sleeves in floors, walls, partitions, ceilings and roof slabs as construction progresses to permit their work to be built into place and to eliminate unnecessary cutting of construction work.
- B. All cutting of concrete, or other material for the passage of piping through floors, walls, partitions and ceiling shall be done by the respective contractor where necessary to install his work. Respective contractor will close all such openings around piping with materials equivalent to that removed. All exposed surfaces shall be left in suitable condition for refinishing without further work.
- C. Contractor shall patch and repair any existing openings created by the demolition work in floors, walls, partitions, and ceilings not being reused for the new construction.

3.22 INVERTS AND ELEVATIONS

- A. Indicated inverts and elevations of existing utilities are approximate and based on the best information available.
- B. Upon award of contract, contractor shall verify in the field all such information and report any discrepancies before proceeding with work. Contractor shall be responsible for extra work caused by his failure to verify inverts and elevations.

3.23 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

- A. Furnish and install final connections to equipment furnished in other parts of the specification or furnished by the owner. Provide drainage connections, vent connections, water connections, fuel gas connections, gas connections to the fixtures or equipment. Plumbing connections shall include valved supplies and trapped waste connections.

3.24 BOILER ROOM DRAWING

3.25 COORDINATION DRAWINGS

- A. Provide 3/8" = 1'-0" scale drawings showing all coordinated ductwork, piping, conduit, and equipment of all trades.
- B. The sheet metal shop drawings may be used as the basis of these drawings.
- C. Show ductwork, walls, beams, steel, drainage piping, domestic water piping, HVAC piping, sprinkler piping, light fixtures, electrical conduit and equipment.
- D. Contact other disciplines and obtain information to identify fully coordinated systems.
- E. Submit for review and approval to the A/E.
- F. Provide all dimensional data and necessary clearances to other trades for installation of fixtures and equipment within casework and counter tops.
- G. Work shall not proceed until coordination is completed and all conflicts, issues, sequences etc., are resolved.

3.26 WELDING

- A. All electric power for arc welding shall be supplied by the contractor performing the work.

3.27 VEHICLES

- A. Vehicle access to the site will be as directed by the owner.

3.28 RUBBISH DISPOSAL

- A. Burning of debris on the site shall not be permitted. All debris, refuse, and waste shall be removed from the premises at regular intervals. No accumulation shall be permitted.

3.29 PROTECTION

- A. Maintain all public walks and access ways.
- B. Erect and maintain barricades, warning signs, and other protective means as may be directed by the owner for protection of all persons and property from injury or damage.

3.30 SCAFFOLDING

- A. The contractor shall at his own expense, install, operate, protect, and maintain temporary services such as scaffolding, material hoists, access walks, etc., as may be required.

3.31 UTILITIES

- A. The contractor may use the existing water and electric power for temporary construction needs.
- B. The owner will direct where these services may be tapped.
- C. Those services that are used during construction, but are to remain, shall be refurbished to as new condition before turning back to the owner.

3.32 CLEANUP

- A. Remove all visible temporary tags or labels as well as any protective coverings and wrappings from fixtures and equipment.
- B. Remove all spots, stains, soil, paint, spackle, and other foreign matter from all finished work.
- C. Clean and polish all plumbing fixtures.
- D. Remove all trash and debris from the premises.

3.33 MOUNTING HEIGHTS

- A. Contractor to coordinate all mounting heights with all trades and architect prior to rough-in.

3.34 WORK COMPLETION

- A. The contractor shall promptly correct work rejected by the engineer failing to conform to the requirements of the contract documents, whether discovered before or after substantial completion and whether or not fabricated, installed or completed. Costs of correcting such rejected work, including additional testing and inspections and compensation for the engineer's services and expenses made necessary thereby, shall be at the contractor's expense.

3.35 REQUEST FOR INFORMATION (RFI) REQUIREMENTS

- A. All RFI's shall include the following information based on AIA Document G716:
 - 1 To, From, Project Name, Issue Date, RFI number in sequential order with all other

- trades, Requested Reply Date.
- 2 Provide a description with specification and/or drawing references.
 - 3 Provide the senders recommendation including cost and/or schedule considerations.
 - 4 Provide receiver's reply space.
 - 5 Note an RFI reply is not an authorization to proceed with the work involving additional cost/time.

3.36 SHOP DRAWING REQUIREMENTS

- A. The following is a list of required shop drawings for the project. Not all items may be identified, and it is the responsibility of the contractor to submit additional shop drawings where indicated in the specifications.

PLUMBING	DATE REC'D	ACTION	DATE REC'D	ACTION
COORDINATION DRAWINGS				
VALVES, STRAINERS				
BACKFLOW PREVENTORS				
MIXING VALVES				
PIPING/FITTINGS/LABELING				
DRAINS				
FIXTURES/TRIM/CARRIERS				
GAS PRESSURE REGULATORS				
ELEVATOR PIT SUMP PUMPS				
INSULATION A. HANDICAP COVERS B. DOMESTIC WATER PIPING C. TANKS D. EQUIPMENT				
WATER HEATERS				
HOT WATER RETURN PUMPS				
AS-BUILT DRAWINGS/ELECTRONIC AS-BUILT				
WARRANTIES AND GUARANTEES				
OPERATIONS AND MAINTENANCE MANUALS				
INSTRUCTIONS				
TESTS/CERTIFICATIONS				

PLUMBING	DATE REC'D	ACTION	DATE REC'D	ACTION
HOT WATER RETURN BALANCING REPORT				
EMERGENCY AND MANUFACTURER CONTACTS				
DOMESTIC WATER BOOSTER PUMP				

END OF SECTION

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 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

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg. C and at altitude of 3300 feet above sea level.
- B. 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.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

- G. Temperature Rise: Match insulation rating.
- H. Insulation:
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. 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.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. 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.
 - 2. Energy and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. 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 shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 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 waterstop 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.

2.02 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. GPT; an EnPro Industries company.
 - 3. Metraflex Company (The).
 - 4. Proco Products, 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: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.03 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**3.01 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. 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.
 - 2. 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 079200 "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 078413 "Penetration Firestopping."

3.02 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.

3.03 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-inch: Cast-iron wall sleeves.
- b. Piping NPS 6-inch and Larger: Cast-iron wall sleeves.
- 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6-inch Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6-inch and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6-inch: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6-inch and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6-inch: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6-inch and Larger: Galvanized-steel-pipe sleeves.
- 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6-inch: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6-inch and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Escutcheons
 - 2. Floor plates

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

- A. One Piece, Cast-Brass Type: With polished, chrome-plated, and rough-brass finish and setscrew fastener.
- B. One Piece, Deep-Pattern Type: Deep-drawn, box shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One Piece, Stamped-Steel Type: With chrome plated finish and spring-clip fasteners.

2.02 FLOOR PLATES

- A. One Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.01 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:
 - 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.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece,

- e. cast-brass type with polished, chrome-plated finish.
Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, stamped-steel type.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
 - j. Bare Piping in Equipment Rooms: One piece, cast-brass type with polished, chrome-plated finish.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
- 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: One piece, floor plate type.

3.02 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 22 05 19 - THERMOMETERS AND GAUGES FOR PLUMBING 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. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Liquid-in-glass thermometers.
 - 3. Thermowells.
 - 4. Dial-type pressure gauges.
 - 5. Gage attachments.

1.03 ACTION SUBMITTALS

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

1.04 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ashcroft Inc.
 - 2. Nanmac Corporation.
 - 3. Palmer Wahl Instrumentation Group.
 - 4. Watts; a Watts Water Technologies company.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Glass Thermometer Corp.
- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch nominal diameter.

- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg. F and deg. C.
- E. Connector Type(s): Union joint, adjustable angle rigid, back and rigid, bottom , 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: Plain glass or plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus, or minus 1 percent of scale range.

2.02 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.
 - 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-inch, 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

2.03 PRESSURE GAUGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gauges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Flo Fab Inc.
 - e. Noshok.
 - f. Palmer Wahl Instrumentation Group.
 - g. REOTEMP Instrument Corporation.
 - h. Watts; a Watts Water Technologies company.
 - i. Weiss Instruments, Inc.
 - j. Weksler Glass Thermometer Corp.
 - k. WIKA Instrument Corporation.
 - 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 -inch 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 or plastic.
 - 10. Ring: Metal.
 - 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gauges:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Flo Fab Inc.
 - d. Noshok.
 - e. Palmer Wahl Instrumentation Group.
 - f. Watts; a Watts Water Technologies company.
 - g. Weiss Instruments, Inc.
 - h. WIKA Instrument Corporation.
 - 2. Standard: ASME B40.100.
 - 3. Case: Liquid-filled Sealed type; cast aluminum or drawn steel 4 ½ -inch nominal diameter with back flange and holes for panel mounting.
 - 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - 5. Pressure Connection: Brass, with NPS 1/4-inch 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 or plastic.
 - 10. Ring: Metal.
 - 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.04 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4-inch, 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, NPS 1/4-inch B1.20.1 pipe threads.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install thermowells with socket extending a minimum of 2 inches into fluid 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 direct-mounted pressure gauges in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gauges on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
 - 2. Inlets and outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
 - 4. Inlet and outlet of each remote domestic water chiller.
- K. Install pressure gauges in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.
- L. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.
- M. Adjust faces of meters and gauges to proper angle for best visibility.

3.02 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
 - 1. .
 - 2. Metal Plastic case, compact industrial-style, liquid-in-glass type.
- B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
 - 1. Metal Plastic case, compact industrial-style, liquid-in-glass type.
- C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
 - 1. Metal case, compact industrial-style, liquid-in-glass type.
- D. Thermometer stems shall be of length to match thermowell insertion length.

3.03 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg. F.
- B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg. F.
- C. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg. F.
- D. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg. F.

3.04 PRESSURE GAGE SCHEDULE

- A. Pressure gauges at discharge of each water service into building shall be one of the following:
 - 1. Liquid-filled Sealed Solid-front, pressure-relief, direct mounted, metal case.
 - 2. Sealed direct mounted, plastic case.
- B. Pressure gauges at inlet and outlet of each water pressure-reducing valve shall be one of the following:
 - 1. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.
- C. Pressure gauges at suction and discharge of each domestic water pump shall be one of the following:

1. Liquid filled Sealed Solid front, pressure relief direct mounted, metal case.

3.05 PRESSURE GAGE SCALE RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 160 psi.
- B. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION

SECTION 22 05 23.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Bronze ball valves.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- 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 B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 3. ASME B16.18 for solder-joint connections.
 - 4. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- 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 Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
 - 2. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.02 BRASS BALL VALVES

2.03 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim:

1. Manufacturers:
 - a. Apollo Valves
 - b. Hammond Valve
 - c. Milwaukee Valve Co.
 - d. NIBCO Inc.
 - e. Red-White Valve Corp.
 - f. Stockham
 - g. Viega LLC
 - h. WATTS
 - i. Zurn Industries, LLC
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

PART 3 - EXECUTION

3.01 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. 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.

3.02 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves 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.

3.03 DOMESTIC HOT- AND COLD-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 ball valves, two-piece with full port and bronze or brass trim.

END OF SECTION

SECTION 22 05 23.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Bronze swing check valves.
 - 2. Iron swing check valves.
 - 3. Iron swing check valves with closure control.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- 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 B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder joint.
 - 5. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- 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 Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE SWING CHECK VALVES

- A. Bronze Swing Check Valves with Bronze Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Valve, Inc.
 - b. Apollo Valves; Conbraco Industries, Inc.
 - c. Crane; Crane Energy Flow Solutions.

- d. Hammond Valve.
 - e. Jenkins Valves; Crane Energy Flow Solutions.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corporation.
 - i. Stockham; Crane Energy Flow Solutions.
 - j. Watts; a Watts Water Technologies company.
- 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.
- B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane; Crane Energy Flow Solutions.
 - b. Hammond Valve.
 - c. Jenkins Valves; Crane Energy Flow Solutions.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Red-White Valve Corporation.
 - g. Stockham; Crane Energy Flow Solutions.
 - h. Watts; a Watts Water Technologies company.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.

PART 3 - EXECUTION

3.01 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. 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 swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.02 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.

3.03 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 inch and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2 ½ - inch and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; metal-seat or resilient-seat check valves.
 - c. NPS 2 ½ - inch and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
 - 1. For Copper Tubing, NPS 2-inch and Smaller: Threaded or soldered.
 - 2. For Copper Tubing, NPS 2 ½ -inch to NPS 4-inch: threaded.
 - 3. For Steel Piping, NPS 2-inch and Smaller: Threaded.
 - 4. For Steel Piping, NPS 2 ½ -inch to NPS 4-inch: Flanged.
 - 5. For Steel Piping, NPS 5-inch and Larger: Flanged.

3.04 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

- A. Pipe NPS-2-inch and Smaller:
 - 1. Horizontal and Vertical Applications: Bronze swing check valves bronze nonmetallic disc, Class 125, with soldered or threaded end connections.
- B. Pipe NPS 2 ½ - inch and Larger:
 - 1. Iron swing check valves with metal nonmetallic-to-metal seats, Class 125, with threaded or flanged end connections.

3.05 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2-inch and Smaller: Bronze swing check valves bronze nonmetallic disc, Class 125, with soldered or threaded end connections.
- B. Pipe NPS 2 ½ - inch and Larger:
 - 1. Iron swing check valves with metal nonmetallic-to-metal seats, Class 125, with threaded or flanged end connections.

END OF SECTION

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Pipe positioning systems.
 - 6. Equipment supports.

1.02 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 plumbing 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 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.

1.03 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. 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.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.05 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

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100- or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.04 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: 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. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated stainless- steel anchors, for

use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.06 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.07 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-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 (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal 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 the building structure.
- B. Metal 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 for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. 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.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. 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-inch 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.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. 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. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4-inch 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-inch and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4-inch to NPS 3 1/2 -inch: 12 inches long and 0.048 inch thick.
 - b. NPS 4-inch: 12 inch long and 0.06 inch thick.
 - c. NPS 5-inch and NPS 6-inch: 18 inches long and 0.06 inch thick.
 - d. NPS 8-inch to NPS 14-inch: 24 inches long and 0.075 inch thick.
 - e. NPS 16-inch to NPS 24-inch: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8-inch 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 same thickness as piping insulation.

3.02 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.

3.03 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.

3.04 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 ½ - inch.

3.05 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 a minimum dry film thickness of 2.0 mils.
- B. galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are 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 carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use stainless-steel 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 padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. 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-inch to NPS 30-inch.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg. F, pipes NPS 4-inch to NPS 24-inch, 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-inch to NPS 36-inch, requiring clamp flexibility and up to 4 inches of insulation.
 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2-inch to NPS 8-inch.
 5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2-inch to NPS 30-inch.
 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4-inch to NPS 36-inch, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4-inch to NPS 36-inch, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1-inch to NPS 30-inch, from two rods if longitudinal movement caused by expansion and contraction might occur.
 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2-inch to NPS 42-inch if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- K. 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.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. 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.
- M. 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. 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.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

- 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- 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. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1 ¼ inches.
 - 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 - 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 33 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:
 - 1. Plastic insulated, series resistance.
 - 2. Self-regulating, parallel resistance.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For electric heating cable.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Manufacturers:
 - 1. Speed Trace
 - 2. Brisk Heat
 - 3. Frost Guard
 - 4. Raychem
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 AWG, [tinned] [nickel-coated], stranded copper bus wires

embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.
- F. Maximum Operating Temperature (Power On): 150 deg F.
- G. Maximum Exposure Temperature (Power Off): 185 deg F.
- H. 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.
- I. Capacities and Characteristics:
 - 1. Maximum Heat Output: 3 W/ft.
 - 2. Electrical Characteristics for Single-Circuit Connection:
 - a. Volts: [120] [208] [240] [277] [480].
 - b. Phase: 1 or 3

2.02 CONTROLS

- A. Pipe-Mounted Thermostats for Freeze Protection:
 - 1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F (minus 1 to plus 10 deg C).
 - 2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
 - 3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
 - 4. Corrosion-resistant, waterproof control enclosure.
- B. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:
 - 1. Microprocessor based.
 - 2. Minimum of four separate schedules.
 - 3. Minimum 24-hour battery carryover.
 - 4. On-off-auto switch.
 - 5. 365-day calendar with 20 programmable holidays.
 - 6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control-system workstation.

2.03 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.
- B. Warning Labels: Refer to Section 220553 "Identification for Plumbing 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

3.01 APPLICATIONS

- A. Install the following types of electric heating cable for the applications described:
 - 1. Exposed outdoor piping or heating cable.
 - 2. Temperature Maintenance for Domestic Hot Water: Self-regulating, parallel-resistance heating cable.

3.02 INSTALLATION

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- B. Electric Heating-Cable Installation for Freeze Protection for Piping:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed.
 - 2. Install electric heating cables according to IEEE 515.1.
 - 3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
 - 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- C. Set field-adjustable switches and circuit-breaker trip ranges.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 2. Test cables for electrical continuity and insulation integrity before energizing.
 - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers:
 - a. Brady Corporation
 - b. Brimar Industries, Inc.
 - c. Craftmark Pipe Makers
 - d. Marking Services, Inc.
 - e. Seton Identification Products
 - 2. Material and Thickness: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 3. Letter Color: Black.
 - 4. Background Color: Yellow.
 - 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-quarters 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.
- B. Plastic Labels for Equipment:
 - 1. Manufacturers:
 - a. Brady Corporation
 - b. Brimar Industries, Inc.
 - c. Craftmark Pipe Markers

- d. Marking Services, Inc.
- e. Seton Identification Products
- 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- 3. Letter Color: Black.
- 4. Background Color: Yellow.
- 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- 7. 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-quarters the size of principal lettering.
- 8. Fasteners: Stainless-steel rivets or self-tapping screws.
- 9. 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.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

- A. Manufacturers:
 - 1. Brady Corporation
 - 2. Brimar Industries, Inc.
 - 3. Craftmark Pipe Makers
 - 4. Marking Services Inc.
 - 5. National Marker Company
 - 6. Seton Identification Products
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. 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-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS

- A. Manufacturers:
 - 1. Brady Corporation
 - 2. Brimar Industries, Inc.
 - 3. Craftmark Pipe Makers
 - 4. Marking Services Inc.
 - 5. Seton Identification Products
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover 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 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: Size letters according to ASME A13.1 for piping At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

PART 3 - EXECUTION

3.01 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.02 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings unfinished 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 and on both sides of 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.
- B. Pipe Label Color Schedule:
 - 1. Low-Pressure Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.

2. High-Pressure Compressed Air Piping:
 - a. Background: Safety blue.
 - b. Letter Colors: White.
3. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
4. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Yellow
 - b. Letter Color: Black.

END OF SECTION

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Domestic recirculating hot water piping.
 - 4. Roof drains and rainwater leaders.
 - 5. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
 - 1. Section 220716 "Plumbing Equipment Insulation."

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 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.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing 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 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.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation 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. Flexible Elastomeric Insulation: Closed-cell, sponge or expanded rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 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.
- H. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armacell LLC.
 - b. Nomaco Insulation.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.

2.03 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: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg. F.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive 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."
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. K-Flex USA.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Corning Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. P.I.C. Plastics, Inc.
 - d. Speedline Corporation.

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Knauf Insulation.
 - c. Vimasco Corporation.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient

services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Knauf Insulation.
 - e. Mon-Eco Industries, Inc.
 - f. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg. F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.05 SEALANTS

- A. Joint Sealants for Cellular-Glass Products:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - e. Pittsburgh Corning Corporation.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 100 to plus 300 deg. F.
 5. Color: White or gray.
- B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 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.

2.06 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.

2.07 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Vimasco Corporation.

2.08 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: White or Color-code jackets based on system. Color as selected by Architect.
 - 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.

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Venture Tape.
 - 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.

- d. Knauf Insulation.
 - e. Venture Tape.
 - 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 lb./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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Compac Corporation.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Venture Tape.
 - 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.

2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. C & F Wire.

2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Engineered Brass Company.
 - b. Insul-Tect Products Co.
 - c. McGuire Manufacturing.
 - d. Plumberex Specialty Products, Inc.
 - e. Truebro.
 - f. Zurn Industries, LLC.
 - 2. 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.

- B. Protective Shielding Piping Enclosures
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Truebro.
 - b. Zurn Industries, LLC.
 - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.01 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.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of 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 ½ - 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, according to insulation material manufacturer's written instructions, 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.

3.03 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.
 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.04 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. 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.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- 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 manufacturer's 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.

3.06 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

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. Instead, 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.

3.07 INSTALLATION OF POLYOLEFIN INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Seal split-tube 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 polyolefin sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's 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.

3.08 FIELD-APPLIED JACKET INSTALLATION

- A. 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 ½ -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.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. 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.
- C. 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.

3.09 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 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.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. 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.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 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.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot and Recirculated Hot Water, 100°F-140°F:
 - 1. Pipe size $\leq 1"$
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - c. Polyolefin: 1 inch thick.
 - 2. $1" < \text{Pipe size} \leq 1\frac{1}{2}"$
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - c. Polyolefin: 1 inch thick.
 - 3. $1\frac{1}{2}" < \text{Pipe size} \leq 4"$
 - a. Flexible Elastomeric: 1.5 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1.5 inch thick.

- c. Polyolefin: 1.5 inch thick.
- B. Domestic Cold Water
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- C. Stormwater and Overflow: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- D. Roof Drain and Overflow Drain Bodies: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 3. Polyolefin: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:
 - 1. Polyolefin: 1/2 inch thick.
- F. Sanitary Waste Piping Where Heat Tracing Is Installed: Mineral-fiber, preformed pipe insulation, Type I, 1 1/2 - inches thick.

3.13 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, Concealed:
 - 1. None.
 - 2. PVC: 20 mils thick.
- D. Piping, Exposed:
 - 1. None.
 - 2. PVC: 20 mils thick.

3.14 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping: Insulation shall be one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Flexible Elastomeric: 2 inches thick.
 - 3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
 - 4. Polyolefin: 2 inches thick.
- B. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Flexible Elastomeric: 2 inches thick.
 - 3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
 - 4. Polyolefin: 2 inches thick.
- C. Sanitary Waste Piping Where Heat Tracing Is Installed: Insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

END OF SECTION

SECTION 22 11 13 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for water service fire-service mains combined water service and fire-service mains.
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 - 3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- D. NSF Compliance:
 - 1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
 - 2. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.

1.06 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements

indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.07 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- C. 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. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
- D. PVC, AWWA Pipe: AWWA C900, Class 150 and Class 200, with bell end with gasket, and with spigot end.
1. PVC Fabricated Fittings: AWWA C900, Class 150 and Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 2. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 3. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 4. 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.

2.02 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8, BCuP Series.
- B. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping

system manufacturer, unless otherwise indicated.

2.03 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
 - 1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
 - a. Standard: AWWA C219.

2.04 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
 - 1. Manufacturers:
 - a. American Cast Iron Pipe Co.
 - b. Crane
 - c. Flomatic Valves
 - d. Kennedy Valve Co.
 - e. Mueller Co.
 - f. NIBCO Inc.
 - g. Tyler Pipe
 - h. U.S. Pipe and Foundry Co.
 - i. Zurn Industries, LLC
 - 2. Nonrising-Stem, Metal-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
 - 1) Standard: AWWA C500.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
 - 3. Nonrising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
 - 4. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
 - a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 250 psig.
 - 3) End Connections: Push on or mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
 - 5. OS&Y, Rising-Stem, Metal-Seated Gate Valves:
 - a. Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.
 - 1) Standard: AWWA C500.

- 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Flanged.
 - 6. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
 - a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Flanged.
- B. Bronze Gate Valves:
 - 1. Manufacturers:
 - a. Crane
 - b. Hammon Valve
 - c. Jenkins Valves
 - d. Milwaukee Valve Co.
 - e. NIBCO Inc.
 - f. Red-White Valve Corp.
 - g. Stockham
 - h. Zurn Industries, LLC
 - 2. OS&Y, Rising-Stem Gate Valves:
 - a. Description: Bronze body and bonnet and bronze stem.
 - 1) Standards: UL 262 and FMG approved.
 - 2) Minimum Pressure Rating: 175 psig.
 - 3) End Connections: Threaded.
 - 3. Nonrising-Stem Gate Valves:
 - a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable iron handwheel.
 - 1) Standard: MSS SP-80.

2.05 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies:
 - 1. Manufacturers:
 - a. American Cast Iron Pipe Co.
 - b. Kennedy Valve Co.
 - c. McWane, Inc.
 - d. Mueller Co.
 - e. U.S. Pipe and Foundry Co.
 - 2. Description: Sleeve and valve compatible with drilling machine.
 - a. Standard: MSS SP-60.
 - b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - c. Valve: AWWA, cast-iron, nonrising-stem, [metal] [resilient]-seated gate valve with one raised face flange mating tapping-sleeve flange.
- B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
 - 1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to

operate deepest buried valve, and socket matching valve operating nut.

2.06 CORPORATION VALVES AND CURB VALVES

- A. Manufacturers:
 - 1. Jones, James Co.
 - 2. Master Meter, Inc.
 - 3. Mueller Co.
 - 4. Red Hed Manufacturing Co.
- B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
 - 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 - 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
 - 3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
- D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
 - 1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.07 WATER METERS

- A. Water meters will be furnished by utility company.
- B. Manufacturers:
 - 1. AMCO Water Metering Systems
 - 2. Badger Meter, Inc.
 - 3. Hays Fluid Controls
 - 4. McCrometer, Inc.
 - 5. Mueller Co.
 - 6. Neptune Technology Group
 - 7. Sensus Metering Systems
- C. Displacement-Type Water Meters:
 - 1. Description: With bronze main case.
 - a. Standard: AWWA C700.
 - b. Registration: Flow in [gallons (liters)] [cubic feet (cubic meters)].
- D. Compound-Type Water Meters:
 - 1. Description:
 - a. Standard: AWWA C702.
 - b. Registration: Flow in gallons (liters) cubic feet (cubic meters).

2.08 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principal Backflow Preventers:
 - 1. Manufacturers:

- a. Apollo Valves
 - b. FEBCO
 - c. WATTS
 - d. Wilkins
 - e. Zurn Industries
 2. Standard: ASSE 1013 or AWWA C511.
 3. Operation: Continuous-pressure applications.
 4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 7. Configuration: Designed for horizontal, straight through flow.
 8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
- B. Double-Check, Backflow-Prevention Assemblies:
1. Manufacturers:
 - a. Apollo Valves
 - b. FEBCO
 - c. WATTS
 - d. Wilkins
 - e. Zurn Industries
 2. Standard: ASSE 1015 or AWWA C510.
 3. Continuous-pressure applications, unless otherwise indicated.
 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 7. Configuration: Designed for horizontal, straight through flow.
 8. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

2.09 CONCRETE VAULTS

- A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
1. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
 2. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
 - a. Dimension: 24-inch minimum diameter, unless otherwise indicated.
 3. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
 - a. Dimension: 24-inch minimum diameter, unless otherwise indicated.
 4. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed

bronze ball or clapper-type backwater valve.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Refer to Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping NPS 3/4 to NPS 3 shall be soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings; and brazed joints.
- F. Underground water-service piping NPS 4 and NPS 6 shall be any of the following:
1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed or mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
 2. NPS 4 and NPS 6: NPS 6 PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 molded fittings; and gasketed joints.
- G. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 shall be same as underground water-service piping.
- H. Aboveground [and Vault] Water-Service Piping NPS 3/4 to NPS 3 shall be hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings; and brazed joints.
- I. Aboveground and vault water-service piping NPS 4 and NPS 6 shall be any of the following:
1. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings; and brazed joints.
 2. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
- J. Underground Fire-Service-Main Piping NPS 4 to NPS 8 shall be [any of] the following:
1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
- K. Aboveground and Vault Fire-Service-Main Piping NPS 4 to NPS 8 shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
- L. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 10 shall be any of the following:
1. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
 2. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC fabricated or

- molded fittings of same class as pipe; and gasketed joints.
- M. Aboveground and Vault Combined Water Service and Fire-Service-Main Piping NPS 6 to NPS 10 shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.03 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, metal resilient seated gate valves with valve box.
 2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
 3. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 2 and Smaller: Bronze, nonrising stem.
 - b. Gate Valves, NPS 3 and Larger AWWA, cast iron, OS&Y rising stem, resilient seated UL/FMG, cast iron, OS&Y rising stem.

3.04 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Section 330500 "Common Work Results for Utilities" for piping-system common requirements.

3.05 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.
- B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.
- C. Make connections larger than NPS 2 with tapping machine according to the following:
1. Install tapping sleeve and tapping valve according to MSS SP-60.
 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- D. Make connections NPS 2 and smaller with drilling machine according to the following:
1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 4. Install corporation valves into service-saddle assemblies.
 5. Install manifold for multiple taps in water main.
 6. Install curb valve in water-service piping with head pointing up and with service box.

- E. Comply with NFPA 24 for fire-service-main piping materials and installation.
 - 1. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- F. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- G. Install PE pipe according to ASTM D 2774 and ASTM F 645.
- H. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- I. Bury piping with depth of cover over top at least 30 inches, with top at least 12 inches below level of maximum frost penetration.
- J. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 - 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- K. Sleeves are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- L. Mechanical sleeve seals are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- M. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.06 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
 - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 - 2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
 - 3. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
 - 4. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
 - 5. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
 - 6. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.07 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Heat-fused joints.
 - 6. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs, and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

- 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
- 3. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.08 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- C. MSS Valves: Install as component of connected piping system.
- D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.09 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written instructions.
- B. Water Meters: Install displacement-type water meters, NPS 2 and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
- C. Water Meters: Install compound-type water meters, NPS 3 and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.10 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.11 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891.

3.12 CONNECTIONS

- A. Connect water-distribution piping to interior [domestic water] [and] [fire-suppression] piping.
- B. Connect waste piping from concrete vault drains to sanitary sewerage system. See Section 221313 "Facility Sanitary Sewers" for connection to sanitary-sewer storm-drainage system. See Section 334100 "Storm Utility Drainage Piping" for connection to storm-sewer piping.

3.13 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

3.14 IDENTIFICATION

- A. Install continuous underground warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping.
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel.

3.15 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
 - 3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction.Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Copper tube and fittings.
 - 2. Ductile-iron pipe and fittings.
 - 3. Piping joining materials.
 - 4. Transition fittings.
 - 5. Dielectric fittings.
- B. Related Requirements:
 - 1. Section 221113 "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water service piping enters the building.

1.02 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.
- B. Sustainable Design Submittals:

1.03 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.01 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.
- B. Comply with NSF Standard 372 for low lead.

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.

3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.
- G. Copper Pressure-Seal-Joint Fittings:
 1. Fittings for NPS 2-inch and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
 2. Fittings for NPS 2 ½ to NPS 4-inch: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.03 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 2. 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 Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.04 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.

2.05 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Central Plastics Company.
 - b. Jomar Valve.
 - c. Matco-Norca.
 - d. Watts; a Watts Water Technologies company.
 - e. Wilkins.
 - f. Zurn Industries, LLC.
 2. Standard: ASSE 1079.
 3. Pressure Rating: 125 psig minimum at 180 deg. F.
 4. 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. Capitol Manufacturing Company.
 - b. Central Plastics Company.

- c. Matco-Norca.
 - d. Watts; a Watts Water Technologies company.
 - e. Wilkins.
 - f. Zurn Industries, LLC.
- 2. Standard: ASSE 1079.
- 3. Factory-fabricated, bolted, companion-flange assembly.
- 4. Pressure Rating: 125 psig minimum at 180 deg. F.
- 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating 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.
 - 2. Nonconducting materials for field assembly of companion flanges.
 - 3. Pressure Rating: 150 psig
 - 4. Gasket: Neoprene or phenolic.
 - 5. Bolt Sleeves: Phenolic or polyethylene.
 - 6. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products.
 - c. Matco-Norca.
 - d. Precision Plumbing Products.
 - e. Victaulic Company.
 - 2. Standard: IAPMO PS 66.
 - 3. Electroplated steel nipple complying with ASTM F 1545.
 - 4. Pressure Rating and Temperature: 300 psig at 225 deg. F.
 - 5. End Connections: Male threaded or grooved.
 - 6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.01 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.02 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 ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- J. 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.
- K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- L. Install piping to permit valve servicing.
- M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the 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 for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- R. Install thermostats in hot water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 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 for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: 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. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. 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.
- H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.04 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. Fittings for NPS 1 ½ -inch and Smaller: Fitting-type coupling.
 - 2. Fittings for NPS 2-inch and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 inch and Smaller: Plastic-to-metal transition fittings or unions.

3.05 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2-inch and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2 ½ -inch to NPS 4-inch: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5-inch and Larger: Use dielectric flange kits.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 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.
 - 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.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 -inch and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1-inch and NPS 1 ¼ -inch: 72 inches with 3/8-inch rod.
 - 3. NPS 1 ½ -inch and NPS 2-inch: 96 inches with 3/8-inch rod.
 - 4. NPS 2 ½ -inch: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5-inch: 10 feet with 1/2-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1 ¼ -inch and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1 1/2 -inch: 108 inches with 3/8-inch rod.
 - 3. NPS 2-inch: 10 feet with 3/8-inch rod.
 - 4. NPS 2 ½ -inch: 11 feet with 1/2-inch rod.
 - 5. NPS 3-inch and NPS 3 ½ inch: 12 feet with 1/2-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for 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 that required by plumbing code.
 - 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 ½ -inch and larger.

3.08 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.09 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. 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:

- 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 authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections, and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. 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 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. 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.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 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 hot-water flow 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.

3.11 CLEANING

- A. Clean and disinfect 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.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 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-inch and smaller, shall be:
 1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings; and brazed copper pressure-seal fittings; and pressure-sealed joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4-inch to NPS 8-inch and larger, shall be one of the following:
 1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- F. Under-building-slab, domestic water piping, NPS 2-inch and smaller shall be one of the following:
 1. Hard or soft copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper, solder-joint fittings; and brazed copper pressure-seal-joint fittings; and pressure-sealed joints.
- G. Aboveground domestic water piping, NPS 2-inch and smaller shall be one of the following:
 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast or wrought-copper, solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper push-on-joint fittings; and push-on joints.
- H. Aboveground domestic water piping, NPS 2 ½ - to NPS 4-inch shall be one of the following:
 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast or wrought copper, solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
- I. Aboveground domestic water piping, NPS 5-inch to NPS 8-inch, shall be one of the following:
 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast or wrought-copper, solder-joint fittings; and soldered joints.
 2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B)); grooved-joint, copper-tube appurtenances; and grooved joints.
- J. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6-inch to NPS 12-inch, shall be one of the following:
 1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

END OF SECTION

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:

1.03 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.02 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. 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.

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.04 COPPER TUBE AND FITTINGS

- A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Copper Pressure Fittings:
 - 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. 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.
- D. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.05 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 2. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers:
 - 1) Fernco Inc
 - 2) Froet Industries LLC
 - 3) Plastic Oddities
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.
 - e. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC, or other material compatible with pipe materials being joined.
 - 3. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers:
 - 1) Cascade Waterworks Mfg.
 - 2) Mission Rubber Co.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.02 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. 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 at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
1. 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.
 2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drainpipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 3. Do not change direction of flow more than 90 degrees.
 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: 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 Waste Piping: 2 percent downward in direction of flow.
 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. 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."
- N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- O. Install aboveground PVC piping according to ASTM D 2665.

- P. Install underground PVC piping according to ASTM D 2321.
- Q. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

- A. 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.
- B. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

3.04 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Waste Drainage Piping: Unshielded nonpressure transition couplings.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment." Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel fiberglass pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install 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.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one 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 and NPS 8: 60 inches with 3/4-inch rod.
 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 2: 84 inches with 3/8-inch rod.
 2. NPS 3: 96 inches with 1/2-inch rod.
 3. NPS 4: 108 inches with 1/2-inch rod.
 4. NPS 6: 10 feet with 5/8-inch rod.
- J. Install supports for vertical stainless-steel piping every 10 feet.
- K. 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 and 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.
- L. Install supports for vertical copper tubing every 10 feet.
- M. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 2. NPS 3: 48 inches with 1/2-inch rod.

- 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
- 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
- N. Install supports for vertical PVC piping every 48 inches.
- O. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.06 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 waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste 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 waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Install horizontal backwater valves with cleanout cover flush with floor.
 - 6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 7. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. 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.

3.07 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.08 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 waste 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.
 - a. 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 waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. 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.
 - a. 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.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. 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.

3.09 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping 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.
- D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

- A. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Copper Type DWV tube, copper drainage fittings, and soldered joints.
 - 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- B. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Copper Type 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 (Type C); copper pressure fittings; and soldered joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 5 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Cast Iron.
 2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- F. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
1. SV Cast Iron.
 2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION

SECTION 22 13 19.13 - SANITARY DRAINS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Trench drains.

1.02 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. HDPE: High-density polyethylene.
- C. PE: Polyethylene.
- D. PP: Polypropylene.
- E. PVC: Polyvinyl chloride.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.02 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
 - 1. Manufacturers:
 - a. Jay R Smith Mfg. Co.
 - b. Josam Co.
 - c. MIFAB, Inc
 - d. Sioux Chief Manufacturing
 - e. Wade
 - f. WATTS
 - g. Zurn Industries, LLC
 - 2. Standard: ASME A112.6.3.
 - 3. Pattern: Area Floor, Funnel floor drain.
 - 4. Body Material: Gray iron.

5. Outlet: Bottom Side.
 6. Top or Strainer Material: Bronze.
 7. Top of Body and Strainer Finish: Nickel bronze.
 8. Top Shape: Round Square.
 9. Trap Material: Bronze.
 10. Trap Pattern: Standard P-trap.
 11. Trap Features: Cleanout.
- B. Plastic Floor Drains:
1. Manufacturers:
 - a. Josam Co.
 - b. Oatey
 - c. Plastic Oddities
 - d. Sioux Chief Manufacturing
 - e. Zurn Industries, LLC
 2. Standard: ASME A112.6.3.
 3. Material: PVC.
 4. Outlet: Bottom Side.
 5. Top or Strainer Material: Bronze.
 6. Top of Body and Strainer Finish: Nickel bronze.
 7. Top Shape: Round Square.
 8. Trap Material: Plastic drainage piping.
 9. Trap Pattern: Standard P-trap.

2.03 TRENCH DRAINS

- A. Trench Drains:
1. Manufacturers:
 - a. Jay R Smith Mfg. Co.
 - b. Josam Co.
 - c. MIFAB, Inc
 - d. Sioux Chief Manufacturing
 - e. Wade
 - f. WATTS
 - g. Zurn Industries, LLC
 2. Standard: ASME A112.6.3 for trench drains.
 3. Material: Ductile or gray iron.
 4. Flange: Anchor.
 5. Clamping Device: Required.
 6. Outlet: Bottom End Side.
 7. Grate Material: Ductile iron or gray iron.
 8. Trap Material: Cast iron.
 9. Trap Pattern: Standard P-trap.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. 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.
 - 3. 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.
 - 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 - 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.
 - 1. Set grates of drains flush with finished surface, unless otherwise indicated.
 - 2. Install on support devices, so that top will be flush with adjacent surface.
- C. Install open drain fittings with top of hub 1 inch (25 mm) above floor.

3.02 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.03 LABELING AND IDENTIFYING

- A. 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 Section 220553 "Identification for Plumbing Piping and Equipment."

3.04 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

SECTION 22 14 13 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
- B. Related Section:
 - 1. Section 334100 "Storm Utility Drainage Piping" for storm drainage piping outside the building.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:

1.03 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.
- B. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.01 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.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers:
 - a. ANACO-Husky
 - b. Charlotte Pipe
 - c. Fernco Inc
 - d. Matco-Norca
 - e. MIFAB, Inc.
 - f. Tyler Pipe
 - 2. Standards: ASTM C 1277 and CISPI 310.
 - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stops.
- C. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers:
 - a. ANACO-Husky
 - b. Charlotte Pipe
 - c. Clamp-All Corp
 - d. MIFAB, Inc
 - e. Tyler Pipe
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stops.

2.04 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
 - 3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers
 - 1) Fernco, Inc
 - 2) Plastic Oddities
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 - 4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Co.
 - b. Standard: ASTM C 1460.

- c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.01 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.02 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 from 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 at indicated slopes.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. 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 storm 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 storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 1 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 Storm-Drainage Piping: 2 percent downward in direction of flow.
- K. 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."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- L. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- M. Install aboveground PVC piping according to ASTM D 2665.
- N. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements

- for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

3.04 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.
 2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel or fiberglass pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. 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.
 - c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3: 60 inches with 1/2-inch rod.
 2. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 3. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 4. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 5. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is

limited to 60 inches.

- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 2. NPS 6: 10 feet with 5/8-inch rod.
 - 3. NPS 8: 10 feet with 3/4-inch rod.
- 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 interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 - 2. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.
 - 3. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.07 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.08 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.
 - 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 storm drainage 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 storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage 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 (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for 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.

3.09 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.

3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
- C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
- D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
- E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:
 1. Extra Heavy Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, or cast-iron, hubless-piping couplings; and coupled joints.
 3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION

SECTION 22 17 00 - GAS PIPING SYSTEMS

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to section 22 05 00 for requirements which are applicable to this section.
- B. Refer to International Mechanical Code.
- C. Refer to requirements of the local gas company.
- D. Refer to NFPA Pamphlet No. 54.
- E. Where the contract documents are more stringent but not in conflict with the applicable codes, the more stringent requirement shall be followed.
- F. Refer to International Fuel Gas Code

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to install a complete natural gas piping system with all devices, appurtenances and accessories to complete the work.
- B. Provide gas cocks on each side of gas meter and pressure regulator. Install gas meter, pressure regulator, and relief valve in accordance with the requirements of the gas company.
- C. Extend service from termination point of the gas company to the building.
- D. Provide gas cocks on all branch lines to equipment and appliances to allow for servicing.
- E. Provide separate gas pressure regulators on each piece of equipment and appliance to regulate line pressure down to appliance/equipment usage pressure.
- F. Arrange for service and meter installation with utility supplier.
- G. Contractor shall paint all exterior piping exposed to the outdoors with one coat of primer and two coats of enamel paint. Finish to be selected by architect, and/or as required by the utility company.
- H. Furnish and install gas booster system, piping, appurtenances, and controls. Gas booster system installation to be in accordance with PGW requirements.

1.03 MATERIAL REQUIREMENTS

- A. Steel pipe schedule 40: ASTM A53 and A106, Interior piping.
- B. Plastic pipe schedule 40: ASTM D2513 and D2517, Exterior underground piping.

1.04 PRESSURE REQUIREMENTS

- A. Service pressure from main to meter/regulator:
High pressure from Gas Company.
- B. Pressure Regulator:
High Pressure inches or inches water column.
- C. Relief Valve:
To relieve full connected load + 25% at a pressure of psig.

PART 2 - PRODUCTS

2.01 VALVES

- A. Valves 2 inch and smaller shall be conventional port, three piece body, blow-out proof stem, chrome ball and Teflon seals, 600 PSI rated and UL listed. Model # T-595-Y-UL as manufactured by NIBCO.
- B. Valves over 2 inch shall be Figure 143 with flanged ends as manufactured by Rockwell-Nordstrom.

2.02 ISOLATION FITTINGS

- A. Insulated dielectric unions to prevent the flow of electricity between adjacent sections of piping. Unions shall have the same pressure and temperature ratings of the installed systems.
- B. Fittings shall be screwed union type up to 2 inch and flanged type above 2 inch. Flanged type shall have isolating gaskets and isolated bolt holes.
- C. Manufacturer; Epco Sales Inc., Central Plastics. UL listed for gas piping service.

2.03 UNIONS

- A. All equipment, control valves, and regulators shall be provided with union connections up to 2 inch and flanged connections above 2 inch.
- B. Unions and flanges shall have pressure and temperature ratings equivalent to the fittings in the adjacent piping system. Screwed unions shall be bronze to bronze seat.
- C. Unions shall be placed between the appliance and its shutoff valve.

2.04 SCREWED PIPE FITTINGS

- A. Pipe joints made on screwed pipe shall be sealed with Teflon ribbon wrapped on the threads before assembly.
- B. Usage shall be in conformance with the manufacturer's instructions.

2.05 PRESSURE REGULATOR - SERVICE

- A. In accordance with utility company requirements.

2.06 PRESSURE REGULATOR - EQUIPMENT/APPLIANCES

- A. Individual appliance gas pressure regulators shall be provided for each individual appliance to reduce pressure from line pressure to appliance pressure.
- B. Pressure regulators shall be UL listed for gas service.
- C. Pressure regulators shall be accessible and protected from physical damage.
- D. Exterior regulators shall be approved for outdoor applications.
- E. The vent from vented regulators shall be extended to the exterior of the building. Vents shall not terminate near windows or door openings, air intakes, areaways or other confined areas where gas may accumulate or cause gas to re-enter building spaces.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS

- A. Branch connections shall be made to the top of horizontal lines. All piping shall be arranged to drain to a drainable low point. The low point shall be provided with a nipple and cap for the removal of moisture.
- B. Piping shall run square with building lines.
- C. Necessary drains, offsets, rises, vents, and drips shall be provided for as part of the contracted work. Where any such rise or drip is necessary the contractor shall install same as part of the work and as directed by the engineer. The drawings are diagrammatic in nature and due to the small scale, it is not possible to show all necessary drains, vents, offsets and rises which may be required to properly execute the work and such items shall be provided as needed. Drips shall be accessible.
- D. Running or close nipples are not allowed.
- E. Furnish and install dielectric pipe couplings between sections of ferrous and nonferrous piping systems and between copper or brass equipment and ferrous piping systems.
- F. Steel piping shall be supported from adjustable clevis type piping up to 1". Over 1" to be on 10'-0" centers. Refer to manufacturer for piping other than steel.
- G. Piping above roof shall be cleaned, primed, and provided with 2 coats of epoxy enamel.
- H. Furnish and install an appliance pressure regulator on all equipment unless otherwise indicated.
- I. Piping shall not be installed underground beneath buildings.
- J. Piping shall be capped immediately after installation.
- K. Valves shall not be concealed above ceilings.

3.02 PIPING IDENTIFICATION

- A. Provide stencils or snap-on labels to identify gas piping systems.
- B. Labels shall indicate "GAS" and the direction of flow.
- C. Labels shall be required where piping enters and leaves mechanical rooms, at inlets and outlets of equipment, at 50 foot intervals where exposed.

3.03 WELDING

- A. All concealed black steel piping shall be fusion welded.
- B. Welding shall be performed in conformance with the ASME Boiler and Pressure Vessel Code Section IX.
- C. Elbows, tees, and branch connections shall be made with welding fittings ANSI B16.9.
- D. Furnish welder test certificates for review. Certificates of successful welder qualification by the following organizations shall be acceptable;
 - ASME Boiler and Pressure Vessel Code
 - ANSI Code for Pressure Piping
 - National Certified Pipe Welding Bureau
 - Military Specification MIL-STD-248.
- E. Weld-o-lets and Thread-o-lets are allowed but shall be a maximum of one size smaller than line size, i.e., a maximum of a 3 inch weld-o-let on a 4 inch pipe.

3.04 VALVES

- A. Valves shall be installed with their stems above the horizontal.
- B. Valves shall be installed on the connections to all equipment and control valves to allow for isolation for repair.
- C. Valves shall not be installed above ceilings.
- D. An emergency shut off valve to shut off the entire system shall be provided, accessible from outside the building.
- E. Minimum depth of bury: 18".
- F. Connections between plastic and steel piping shall only be made outside, underground, with approved fittings.
- G. Piping through foundation walls shall be encased in an approved vented sleeve. The annular space shall be sealed to prevent the leakage of gas into the structure.
- H. TESTING
- I. The gas system shall be tested in accordance with the local gas company and NFPA Pamphlet No. 54.
- J. Provide a report of the test procedure utilized indicating test pressure and duration, date, and signatures of witnesses which shall include the owner, Gas Company official, and representative of the A/E.
- K. Sections of piping which will be concealed shall be tested prior to concealment.
- L. Test pressure shall be 1.5 times the system working pressure but not less than 3 psi. There shall be no loss in pressure for a ten minute period. Repair any leaks and retest.

END OF SECTION

SECTION 22 33 00 – ELECTRIC, DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Commercial, electric, domestic-water booster heaters.
 - 2. Commercial, electric, storage, domestic-water heaters.
 - 3. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 4. Thermostat-control, electric, tankless, domestic-water heaters.
 - 5. Domestic-water heater accessories.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated.
- B. Sustainable Design Submittals:
- C. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Retain first paragraph below if plumbing codes for Project area require domestic-water heaters to be independent-testing-agency certified. Verify availability for units retained.
- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 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/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1 2016.
- C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex, "Drinking Water System Components - Health Effects."

1.06 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

- B. Verify available warranties and warranty periods for units and components with manufacturers listed in Part 2 articles.
1. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Domestic-Water Booster Heaters:
 - 1) Controls and Other Components: Five years.
 - b. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Five years.
 - c. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Three years.
 - d. Residential, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Ten years.
 - 2) Controls and Other Components: Five years.
 - e. Electric, Tankless, Domestic-Water Heaters: Five year(s).
 - f. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.01 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
1. Manufacturers:
 - a. A.O. Smith Corp
 - b. Bradford White Corp
 - c. Lochinvar, LLC
 - d. PVI; A WATTS Brand
 - e. Rheem Manufacturing Co.
 - f. State Industries
 2. Standard: UL 1453.
 3. Storage-Tank Construction: ASME-code, steel horizontal arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 Annex barrier materials for potable-water tank linings, including extending lining material into tappings.
 4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.

- h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
- 5. Special Requirements: NSF 5 construction.

2.02 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

- A. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:
 - 1. Manufacturers:
 - a. Bosch Thermotechnology Co.
 - b. Bradford White Corporation
 - c. Eemax, Inc
 - 2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
 - 3. Construction: Copper piping or tubing complying with NSF 61 Annex barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Thermostat.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
 - 4. Support: Bracket for wall mounting.

2.03 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Compression Tanks:
 - 1. Manufacturers:
 - a. A.O. Smith Corp
 - b. AMTROL, Inc.
 - c. Honeywell International
 - d. State Industries
 - e. Taco Comfort Solutions
 - 2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 - 3. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 Annex barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 - d. If more than one compression tank is required on Project, delete subparagraph below and schedule compression tanks on Drawings.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA

- 90.1 or ASHRAE 90.2.
- D. Heat-Trap Fittings: ASHRAE 90.2.
 - E. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig maximum outlet pressure unless otherwise indicated.
 - F. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
 - G. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
 - H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
 - I. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
 - J. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
 - K. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.04 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in architectural specifications.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base.
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. 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 concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 1. Anchor domestic-water heaters to substrate.

- B. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 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.
 - 5. Anchor domestic-water heaters to substrate.
- C. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping."
- D. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- H. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- I. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- J. Fill electric, domestic-water heaters with water.
- K. Charge domestic-water compression tanks with air.

3.02 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.04 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.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in architectural specifications.
- C. Prepare test and inspection reports.

END OF SECTION

SECTION 22 40 00 - PLUMBING FIXTURES AND EQUIPMENT

- * Code reference - Applies only to projects in Philadelphia

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 22 05 00 for requirements which are applicable to this section.
- B. Reference the requirements of the International Plumbing Code.
- C. Where the contract documents are more stringent but not in conflict with the applicable codes, the more stringent requirements shall be followed.

*

- D. City of Philadelphia Plumbing Code.

1.02 WORK INCLUDED

- A. Furnish and install plumbing fixtures, drains, trim, supplies, fastening devices, carriers, valves, and traps for a complete installation.
- B. Provide connection of all services for soil, waste, vent, cold and hot water.

1.03 SUBMITTALS

- A. Submit shop drawings of all materials and products described in this section and indicated on the drawings including that listed in the schedule on the drawings.
- B. Fixture submittals shall include all trim associated with the china. They shall be incorporated in a single brochure with the items being furnished clearly identified.

1.04 QUALITY ASSURANCE

- A. All fixtures shall be unmarked, uncracked, true, and level. All shall be warranted to not craze, color, or scale.
- B. Installations shall conform to the International Plumbing Code.
- C. Install all materials and equipment in accordance with the manufacturer's instructions and within the warranty requirements.
- D. All handicapped fixtures and their installation shall conform to the Americans with Disabilities Act and Fair Housing Amendments Act (Public Law 101-336).

PART 2 - PRODUCTS

2.01 TRAPS

- A. Fixture traps shall be approved self-cleaning type with clean-outs.

- B. Traps shall be chrome plated cast brass.
- C. Traps for lavatories shall be 1 1/4" x 1 1/2" size.

2.02 TRIM

- A. All trim including faucets, waste fittings, strainers, valves, supplies, nipples, and escutcheons shall be chrome plated cast brass.
- B. Exposed water supply pipes shall be chrome plated brass with loose key angle stops.
- C. Fixtures shall be selected for low water consumption and limited to 1.6 gallons per flush on toilets, 2.2 gpm for faucets, and 2.5 gpm for showers.
- D. Public toilet room faucets shall be self-closing metering type when not indicated for the handicapped. Handicapped faucets shall conform to ADA requirements. Provide an approved temperature limiting device that conforms to ASSE 1070.
- E. All lavatories in public toilet rooms shall have grid type strainers.
- F. Waste connections for handicapped lavatories shall be offset. Contractor is to insulate all exposed domestic water and waste piping with prefab PVC jacketed assemblies.
- G. For fixtures requiring flush valves, they shall be of the low consumption type. Selection shall be for use with the specified fixture.
- H. 'Eco-drive' sensor operated flush valves and faucets shall include regenerating battery system.
- I. Water cooler shall have a bottle filler on the low station.

2.03 CARRIERS

- A. All wall hung fixtures shall be provided with floor mounted carriers.
- B. Floor mounted carriers shall have short pattern foot supports.
- C. Carriers for lavatories shall be concealed arm type.

2.04 MANUFACTURERS

- A. Fixtures; Kohler, American-Standard, Crane.
- B. Seats; Church, Olsonite, Sperzel, Benke, Bemis.
- C. Carriers; Josam, Zurn, Wade, J.R. Smith, Watts.
- D. Faucets; American-Standard, Speakman, Chicago, Kohler, Delta, Moen.
- E. Supplies and Traps; McGuire, Brass Craft, Central Brass, Kohler, American-Standard.
- F. Shower, Mop Receptors and Laundry Trays; Crane/Fiat, Stern/Williams.
- G. Domestic Water Heaters-Gas; Rheem/Rudd, A.O. Smith, Lochinvar, Jackson, State.
- H. Shower Enclosures - Kohler, American Standard, Crane/Fiat.
- I. Flush Valves - Sloan Royal
- J. * Flush Valves - Sloan Regal, Coyne, and Delaney, Zurn.
- K. Insulation for handicapped lavatory and sink connections insulations - Truebro McGuire "pro-wrap".
- L. Alternate flush valve selection where budget consideration requires a lower cost valve and competitive pricing.

2.05 VACUUM BREAKERS

- A. Furnish and install vacuum breakers on all fixtures, trim, or faucets arranged for the connection of hoses. Vacuum breaker shall be located on the discharge side of the valve.
- B. Vacuum breakers shall be chrome plated brass where exposed and rough brass where concealed.

- C. Install vacuum breakers on wall hydrants, hose bibbs, janitor sinks and wherever else required by code.

2.06 WATER HEATER DRAIN PAN

- A. Pan shall be galvanized steel - 24 gauge with a minimum height of 1 ½".
- B. Each pan shall have a 3/4" drain to an acceptable point.

2.07 WATER CLOSET CARRIER SELECTION.

- A. Carrier fitting configuration shall be suitable for the stack location shown on the drawings. Carriers to permit handicapped mounting of fixtures shall be utilized where required.

2.08 WALL HUNG WATER CLOSET SUPPORTS/FITTINGS

- A. Smith No. 0100 series "adjustable" deep rough-in support. Where floor construction is not suitable for deep rough-in, Smith No. 0200 series shallow rough-in type may be used. Where furred wall space is not sufficient for the adjustable series, Smith "compact" No. 0400 series may be used.

2.09 WALL HUNG BLOWOUT WATER CLOSET SUPPORTS/FITTINGS

- A. Smith No. 0300 series "adjustable series fixture supports with type No. 2 closet outlet connection. Where furred wall space is not sufficient for the adjustable series, Smith "compact" No. 0400 series or Smith No. 670 thru 680 waste fitting assemble with type No.2 closet outlet connection may be used.

2.10 FLOOR MOUNTED FLOOR OUTLET WATER CLOSET CONNECTION

- A. Smith No. 9230 cast bronze closet flange assembly complete with 5/16" bronze bolts, chromium plated nuts and washers and approved gasket.

2.11 WALL HUNG BLOWOUT URINALS ON FLOOR MOUNTED SUPPORT

- A. Smith No. 0629, 0630, 0632, or 0633 urinal support with adjustable coupling assembly. Face plate shall be supported by extra heavy cast iron base support which shall be securely bolted to floor construction.

2.12 WALL HUNG BLOWOUT AND WASH-OUT URINALS ON FLOOR MOUNTED SUPPORT

- A. Smith No. 0600 series urinal support. Uprights shall be high-strength steel with block bases securely bolted to floor construction.

2.13 ELECTRIC WATER COOLER WALL SUPPORT

- A. Smith No. 0830 floor mounted support electric water cooler support. Uprights shall be high strength steel with block bases securely bolted to floor construction.
- 2.14 STEEL BACKING PLATE FOR PLUMBING FIXTURES
 - A. Where plumbing fixtures of the arms which support them are specified to be attached to a steel plate in the wall, furnish and install a 1/4" thick by 6" wide steel plate which shall extend at least one stud beyond the first and last fixture mounting points. Fixture or supporting arms shall be securely and firmly attached to the steel plate in accordance with the manufacturer's instructions.
- 2.15 FLAT-SLAB LAVATORIES-CONCEALED ARMS ON BACKING PLATE
 - A. Lavatories shall be punched for Smith No. 0728 concealed arm fixture support with chromium plated threaded escutcheons. The arms shall be securely bolted to steel backing plate in the wall as herein before specified. They shall have positive mechanical locking device and shall be fully adjustable after installation of the finished wall.
- 2.16 FLAT-SLAB LAVATORIES-CONCEALED ARMS ON FLOOR SUPPORT
 - A. Lavatories shall be punched for Smith No. 0700-E fixture support. Fixture support shall have chromium plated threaded escutcheons and concealed arms with positive mechanical locking device. Arms shall be fully adjustable after installation of finished wall. Uprights shall be high-strength steel with block bases securely bolted to floor construction.

PART 3 - EXECUTION

3.01 INSTALLATIONS

- A. Plumbing fixtures shall be installed in a manner to afford easy access for cleaning. Where practical, all piping from fixtures shall run in the most direct route to the wall.
- B. Furnish and install all waste connections, traps, water supplies, final connections, etc., to equipment furnished under other portions of the specifications.
- C. Make final connections to all soil, waste, vent, and water piping to the fixtures.
- D. Fixtures shall be set level and in proper alignment with adjacent walls and fixtures.
- E. All wall hung fixture carriers to be securely anchored to the slab.
- F. Attach floor mounted water closets to floor with wax seal and lag screws. Do not use lead flashing to hold closet in place.
- G. Securely bolt all fixtures to the building construction and unless special hangers are indicated, provide hangers and/or carriers designed specifically for the fixtures by the fixture manufacture.
- H. Caulk all wall hung fixtures between fixture and wall with sealant specified in Section 07900. Provide sealant at all points where mop receptor meets walls and floor.
- I. Install electric water coolers with "P" trap and water shutoff valve within cabinet.
- J. Contractor shall insulate all exposed domestic water and drainage piping under all handicapped lavatories and sinks with pre-formed insulation kit with PVC jacket similar to, Lav-Guard as manufactured by Truebro. There shall be no sharp or abrasive surfaces under the handicapped

lavatories.

- K. Contractor shall provide an offset tailpiece for the handicapped lavatory's drain piping to create space for wheelchair access.
- L. Emergency tempering valves shall be accessibly located above ceilings or provided with a recessed cabinet adjacent to the fixture.

3.02 MOUNTING HEIGHTS

- A. Mount fixtures with the following heights above finished floor, except where noted otherwise.

Water Closet:

Standard	15 inches to top of bowl rim
Handicapped	17 - 19 inches to top of seat

Urinal:

Standard	22 inches to top of bowl rim
Handicapped	17 inches to top of bowl rim

Lavatory:

Standard	31 inches to top of basin rim
Handicapped	34 inches to top of basin rim or 29 inches to underside of basin apron

Drinking Fountain:

Standard	40 inches to top of basin rim
Handicapped	36 inches to bubbler outlet

Water Closet Flush Valves:

Standard	11 inches minimum above bowl rim
Handicapped	Center line of flush valve shall not exceed 44" above fin. fl. Flush valve handle shall extend toward the wide side of stall.

Water Closet Tank Type - Trip Lever

Standard	Per manufacturer
Handicapped	Locate on tank side toward wide side of stall.

END OF SECTION

DIVISION 23 - HVAC

SECTION 23 05 00 - STANDARD CONDITIONS FOR HVAC

PART 1 - GENERAL

1.01 REFERENCE

- A. Requirements established within the portions of this project manual titled Division 1, General Requirements are collectively applicable to the work of this section.
- B. Instructions to Bidders, Special Conditions and addenda as issued are part of this specification.
- C. Mechanical, Plumbing, and HVAC drawings along with all other project drawings and specifications represent the work of this section.
- D. Drawings, Contract, General Conditions and Supplementary Conditions form a part of this section, by reference thereto and shall have the same force and effect as if printed herewith in full. Failure to review these sections shall not relieve the Contractor of his responsibility to fully comply with the terms therein.

1.02 SCOPE

- A. Provide all labor, material, equipment, and supervision necessary to disconnect and remove the existing heating, cooling, and ventilation systems as indicated on the demolition plans. Patch and repair openings in walls, floors, and ceilings, for piping, ductwork, and equipment that was removed, as indicated on the demolition plans.
- B. Provide labor, material, equipment, and supervision necessary to install complete operating mechanical systems as indicated on the drawings and specified herein, including all work at the site and within the proposed construction areas to accomplish the required work.
- C. It shall be the contractor's responsibility to coordinate his work and the work of his subcontractors to ensure that all the work is covered. He shall designate who is responsible for various portions of work which may overlap so that there is complete coverage of all required work. It is the position of the owner and the A/E that all work is the responsibility of the mechanical contractor within this Division of the work.
- D. All work shown on the drawings and not expressly mentioned in the specifications and all work specified but not shown on the drawings, but necessary for the proper execution of same shall be performed by the contractor. It is not the intent of the drawings and specifications to describe every feature and detail of the work.
- E. No additions to the contract amount will be approved for any materials, equipment, or labor to perform additional work unless it can be clearly shown to be beyond the scope and intent of the drawings and specifications.
- F. HVAC contractor's scope of work shall include but not be limited to the following:
 - 1. Air distribution system, associated ductwork, devices, equipment, and insulation.
 - 2. Condensate drainage system. Condensate pumps.
 - 3. Roof penetrations for mechanical work and all associated roof work.
 - 4. Exhaust systems.
 - 5. Demolition of existing work for new work.

6. Test Balance & Adjust.
7. Generator exhaust, ductwork, and exhaust insulation. Generator Room exhaust system.
8. Automatic Temperature Control System.
9. Building automation system and automatic temperature controls.
10. All other work identified in Division 23 and/or on the mechanical drawings except that identified as plumbing or fire protection work.
11. Contractor shall not utilize new HVAC equipment for temporary heating, cooling, and dehumidification purposes. Temporary HVAC is to be provided as described under the architect's general conditions. Contractor is to protect all HVAC equipment during construction and cover all ductwork openings.
12. Provide third party certification of all packaged systems by a Nationally Recognized Testing Laboratory (NRTL) in accordance with OSHA Federal Regulations 29CFR1910.303 and .399 as well as Pamphlet #70 and National Electrical Code Article 90-7.
13. Fire stopping of penetrations. (See Section 23 05 50)

1.03 REGULATIONS, CODES, AND STANDARDS

- A. Work shall be performed in accordance with the latest adopted codes, amendments, regulations, and ordinances of the authorities having jurisdiction. Observe all safety regulations including the requirements of OSHA.
- B. Obtain and pay for all permits, connection charges, inspections, and certificates required to complete the work.
- C. Latest editions of any referenced standards shall govern.
- D. Contractor shall arrange and pay for all tests and inspections specified herein or required by above agencies and furnish required certificate of inspection to owner.
- E. Where the contract documents are more stringent but not in conflict with the applicable codes, the more stringent requirements shall be followed.

1.04 SUBMISSIONS

- A. The procedure for submissions of shop drawings shall be as specified in Division 1, or as a minimum, as indicated below.
- B. Furnish submissions of shop drawings and samples of materials and equipment as indicated in these sections, on the drawings, or as directed by the A/E. Submissions will be made in a timely fashion such that adequate time exists to review the drawings, or material, and arrive at the site in accordance with the project schedule.
- C. Submissions will not be accepted with work defined as "By Others". Identify contractor by name and with his approval so indicated. Submissions are required prior to purchasing, fabrication, or installation of any material or equipment. Submissions shall be reviewed and certified by the submitting contractor that they are in accordance with the project documents.
- D. When requested by the engineer, shop drawings shall be required to be submitted to designated agencies for review and approval prior to submission to the engineer.
- E. Contractor shall arrange and pay for all tests and inspections specified herein or required by above agencies and furnish required certificate of inspection to owner.
- F. Contractor to forward a copy of submittals which have electrical requirements to the Electrical Contractor (EC) for coordination of voltage, amperage, and phase. Response to be received from EC prior to ordering of equipment by mechanical contractor.
- G. Submissions shall include warranties by the manufacturer for equipment being provided. Submissions for commonly related items such as fixtures, trim, carriers, drains shall be

- combined in a single brochure with all items being furnished clearly identified.
- H. Shop drawings and submittals shall be checked and stamped by the contractor before submitting. They shall conform to measurements made at the site, the contract requirements, and coordinated with all other trades.
 - I. Specific models in catalog sheets must be identified as well as all options, voltages, phases, etc. identified so as to be clear on what is being provided.
 - J. Contractor and manufacturers shall be responsible for all physical characteristics of the equipment and field verify with final locations, coordinate with floor plans, confirm service access, clearances, confirm equipment arrangements, electrical disconnect clearances, and pathways/travel/access to the final equipment installation locations. Submission of equipment shop drawing will be deemed evidence of compliance with this requirement. If no shop drawing is submitted, contractor shall be fully responsible for a complete installation and assumes all related costs that affects the contractor and other trades.
 - K. To aid in the preparation of submittals or shop drawings, the engineer can provide the electronic files for use by the contractor. The electronic files will be provided upon execution of the engineer's electronic file release contract prepared specifically for this project. The electronic files will be released in the format used by the architect and engineer to design the project. If this file format is not compatible with the contractor's needs, additional charges for providing the changes to the requested file format may be necessary at \$150/hr. billable to the contractor.
 - L. Model numbers – It is the contractor's responsibility to confirm the latest model numbers at the time of bid. The model number indicated on the drawings are for reference. No additional costs will be accepted if the manufacturer has updated the model number during or after the design process thru to the point of shop drawing issuance. The performance and capacity indicated in the schedules on the drawings take precedent over the model number.

1.05 SITE INSPECTION

- A. Visit site, inspect, and become aware of all conditions which may affect the work. Investigate utilities, protection requirements for adjacent facilities, storage locations, and access to the construction area.
- B. Submission of bid will be deemed evidence of having complied with this request. Contractor may not request additional costs for existing conditions which were evident from inspection of the site.

1.06 SUBSTITUTIONS

- A. Material and equipment specified shall be deemed as that which the bidder's quotation represents.
- B. Once bids are accepted only that material and equipment listed in the specifications or added by addenda shall be acceptable. Substitution information for inclusion in an addenda must be received by the A/E at least 10 days prior to bid opening. If acceptable, an addenda will be issued which will add the additional acceptable manufacturers or materials and be available for all contractors to consider. It shall be a basic premise that a contractor is a lowest bidder because he utilized substituted materials or equipment as opposed to specified materials or equipment.
- C. If the contractor submits alternate equipment, manufacturers, systems, methods, or materials, not specifically identified in the specifications, additional review and investigation time may be required by the engineer. If the engineer determines additional review time is required because of the substitution, then this will be a billable service by the engineer at the

- rate of \$175.00/hr. for such services. Also billable will be any redesign time and revisions to drawings should they be necessary for incorporation into the work. Services will be billable to the contractor making such substitutions and will be payable prior to approval or rejection.
- D. If the contractor elects to submit alternate equipment, manufacturers, systems, methods, or materials, not specifically identified in the drawings and specifications, it is the contractor's responsibility to coordinate the work with other trades and pay for any associated costs with the substitution or change.
 - E. Contractor and manufacturers shall be responsible for all physical characteristics of the equipment and field verify with final locations, coordinate with floor plans, confirm service access, clearances, confirm equipment arrangements, electrical disconnect clearances, and pathways/travel/access to the final equipment installation locations. Submission of equipment shop drawing will be deemed evidence of compliance with this requirement. If no shop drawing is submitted, contractor shall be fully responsible for a complete installation and assumes all related costs that affects the contractor and other trades.

1.07 DRAWINGS AND SPECIFICATIONS

- A. The drawings are generally diagrammatic and necessary field coordination and adjustment must be provided by the contractor prior to installation. Such deviations to the work to allow for coordination shall be kept to a minimum and any such deviations shall be at no extra cost.
- B. When a conflict or contradiction exists either between drawings and specs or between specs or between different drawings or details, the more stringent shall apply.
- C. Drawings and specifications are intended to be taken as a whole and each is to supplement the other. It is not intended that all work must be both shown on drawings and specified in the specifications.
- D. An item shown on the drawings and not indicated in the specifications is to be understood to be required for the project. An item specified and not shown on the drawings is to be understood to be required for the project.
- E. The architects or engineer's interpretation of the documents shall be binding upon the contractor. If a question arises, the contractor shall ask for an interpretation prior to bidding and an answer shall be issued as an addendum to all bidders.
- F. If a question arises after bidding the A/E interpretation shall govern.

1.08 MEASUREMENTS

- A. Before ordering materials or commencing with any work, the contractor shall verify all measurements at the building. Coordination of equipment, materials, spaces, and dimensions are the responsibility of the contractor.

1.09 PROGRESS SCHEDULE

- A. Provide a project schedule which shall show start, sequence of each type of work, milestone schedule, and completion of each type of work, with overall completion date.

1.10 COST SCHEDULE

- A. Provide a detailed cost breakdown indicating labor and material amounts for various types of work.
- B. AIA forms are required for this submission.

1.11 COMPLETION

- A. The contractor shall deliver to the owner, with his request for final payment, copies of all manufacturer's guarantees, equipment instructional manuals, a complete set of all final shop drawings, catalog cuts, service contracts, and other items as may be required elsewhere in the documents.

1.12 OFFICE

- A. The contractor shall set up his job office (desk) where directed by the owner.

1.13 STORAGE

- A. Material shall be stored only where directed by the owner.

1.14 SANITARY

- A. The contractor will at his own expense, provide and maintain in a sanitary condition, a portable chemical toilet.
- B. Toilet will be located where directed by the owner.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All material shall be new and of present day manufacturer.
- B. All material and equipment shall be in conformance with accepted trade standards.
- C. Whenever equipment or material is referred to in the singular, such as "the fan", it shall be deemed to apply to as many such items as may be necessary to complete the installation.
- D. The word "provide" means "furnish and install complete, tested, and adjusted as necessary with all accessories, covers, escutcheons". The word "piping" means pipe, fitting, controls, valves, and hangers as required for a complete system.

2.02 MOTORS

- A. Incorporate latest IEEE and NEMA standards.
- B. All copper windings with ball bearings.
- C. Indoors; drip proof, 40 degree C rise.
- D. Outdoors; totally enclosed 55 degree C rise.
- E. Motors over 10 HP to be high efficiency with PF in excess of 0.9.

2.03 MOTOR STARTERS AND CONTACTORS

- A. Fractional with horsepower up to ½ HP; electrical contract.
- B. Polyphase and single phase above ½ HP: this contract.
- C. Electrical contractor shall install all starters except for those provided as an integral part of equipment.
- D. Polyphase starters shall be magnetic combination type, across-the-line electrically operated,

electrically held, three pole assemblies, with arc extinguishing characteristics, silver to silver renewable contacts, 3 pole thermal bi-metallic, red run pilot light, individual phase protection, with overload heaters matched to motors installed and with 4 auxiliary contact, Hand-off-Auto switch, and control transformer.

- E. For single phase motors above ½ HP provide magnetic combination single phase motor starters with overloads, non-fusible disconnect switch, red run pilot light, integral 120 volt control transformer with dual primary fusing auxiliary contacts.
- F. Starters shall be as manufactured by G. E., Siemens, Square "D", Cerus or Cutler-Hammer.

2.04 EQUIPMENT START UP

- A. Verify that equipment is operating within warranty requirements.
- B. Advise owner and A/E at least two days prior.
- C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to A/E.

2.05 LUBRICATION

- A. Lubricate all equipment in accordance with manufacturer's instructions.
- B. Lubricate prior to start up.
- C. Provide one year's supply of lubricants to the owner.

2.06 OPERATING INSTRUCTIONS AND MANUALS

- A. Properly and fully instruct owner's personnel in the operation and maintenance of all systems and equipment.
- B. Ensure that the owner's personnel are familiar with all operations to carry on required activities.
- C. Such instruction shall be for each item of equipment and each System as a whole.
- D. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, wiring diagrams, control sequences, service requirements, piping diagrams, names, and addresses of vendors, suppliers, and emergency contacts. Three manuals shall be provided.
- E. Provide to the owner any special tools necessary to operate any of the equipment.

2.07 DRAIN PANS

- A. Provide auxiliary galvanized steel condensate drain pan with 1" MPT drain connection for all interior cooling coils, heat pumps, and any other cooling equipment requiring condensate removal. Drain to suitable discharge point acceptable to owner and A/E. Drain lines shall be separate and independent of A/C unit drain system unless provided with interlocked water sensing switch.
- B. All water heaters mounted above the floor shall be provided with drain pans. Drain to suitable discharge point acceptable to owner and A/E. To be visible outfall.
- C. Drains shall slope down in the direction of flow at 1 inch per 8 feet.

PART 3 - EXECUTION

3.01 PROTECTION

- A. Cover duct openings during construction.
- B. Plug or cap open ends of piping systems and conduit.
- C. Stored materials shall be covered to prevent damage by inclement weather, sun, dust, or moisture.
- D. Protect all installed work until accepted in place by the owner. Cover plumbing fixtures and lighting fixtures.
- E. Do not install plates, polished metal escutcheons, thermostats, and other finished devices until masonry, tile, and painting operations are complete or protect otherwise.
- F. Protect all existing or new work from operations which may cause damage such as hauling, welding, soldering, painting, insulating, and covering.

3.02 WORKMANSHIP

- A. Install all work neat, trim, and plumb with building lines.
- B. Install work in spaces allocated.
- C. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.

3.03 EXCAVATION, SHORING, PUMPING, BACKFILLING

- A. Perform all excavation required to install the work. Deposit excavated material so as not to create a slide hazard.
- B. No work shall be placed on rock. Cushion with 6 " layer of crushed stone.
- C. Protect tree roots with burlap covering and maintain moist until backfilled.
- D. Base estimates on excavation which will include earth, sand, clay, rubbish, debris, and all other materials up to one cubic yard in size. Boulders or rock larger than one cubic yard which need to be broken up with pneumatic equipment or explosives will be separately negotiated at the time of discovery with the owner and A/E. Do not proceed with rock excavation until an agreement is reached.
- E. Maintain excavations free of water.
- F. Shore excavations to prevent cave-in in accordance with OSHA regulations and to prevent strains on work put in place until ready to receive backfill.
- G. Backfill with clean material and pneumatically tamp in 8" layers. Remove excess material, including rock, from site or as directed by the A/E.
- H. Backfill piping trenches within 18" of footings, columns, piers, or grade beams, with concrete. Protect piping from direct contact and adherence to concrete.
- I. Return to original condition any areas disturbed for excavation.

3.04 FASTENERS, HANGERS, AND SUPPORTS

- A. Furnish and install all hangers and supports required to suspend, mount, or hang the work.
- B. Furnish and install all miscellaneous steel angles, channels, beams, clips, brackets, and anchors to hang or support the work. Provide submissions for review.
- C. Install concrete inserts before concrete is poured.
- D. Drilled inserts shall not be loaded to more than 1/4 rated capacity with a minimum of 200 lbs.
- E. Powder driven fasteners shall not be allowed for piping larger than 2", or for equipment. When used they shall not be loaded more than 1/8 rated capacity with a minimum of 200 lbs.
- F. All hangers, miscellaneous steel, braces, and supports shall be galvanized, cadmium plated, or painted with corrosion resistant primer and finish coat of epoxy enamel.

- G. Piping shall be supported from adjustable clevis type hangers with insulation pipe saddles as indicated in the piping system specification sections. Piping shall not support other piping.
- H. Support vertical piping and ductwork at floor levels. Piping shall have split rings. Ductwork shall have 1 1/2" angle iron frames.
- I. Provide and install lintels where required for mechanical work and not indicated on architectural or structural drawings.
- J. Furnish steel framing for roof openings and floor openings. Submit details for review.

3.05 SLEEVES

- A. All piping passing through floors or walls shall have sleeves unless holes are cored. Sleeves shall be 16 gage galvanized steel in non-bearing walls, 10 gage galvanized steel for bearing walls, and schedule 40 galvanized pipe in floors. Sleeves shall accommodate insulation. This shall not apply to sprinkler piping.
- B. Sleeves passing through foundation walls not exposed to interior spaces or sleeves passing through slab on grade may be schedule 40 PVC.
- C. Wall sleeves shall finish flush with wall.
- D. Floor sleeves shall extend 1 inch above floor.
- E. Sleeves in walls between interior spaces and unexcavated, exterior, crawl, or backfilled spaces shall be made watertight with "Link-Seal" modular wall and casing seal. Casing shall be schedule 40 galvanized pipe with anchor flange.

3.06 PLATES

- A. Furnish and install chrome plated plates wherever piping passes into finished areas.
- B. Plates shall be securely fastened to piping or building construction.
- C. Floor plates shall cover one inch floor extension.

3.07 OFFSETS, TRANSITIONS, MODIFICATIONS

- A. Furnish and install all offsets necessary to install the work and to provide clearance for the other trades.
- B. Maintain adequate headroom and clearance as directed by the A/E.
- C. Ductwork transitions necessary to accommodate available space or clearance requirements shall be contract requirements.
- D. Incidental modifications necessary to the installation of the systems shall be made as necessary and at the direction of the A/E.
- E. Rises and drops of piping systems shall be provided as required and where directed to allow for clearances to other construction. Drains shall be installed at no additional cost to the owner. The contractor shall allow for such occurrences in his bid.
- F. Ductwork, piping, conduit, and equipment shall be so arranged as to not pass in front of windows, doors, access panels, access doors, coil removal or filter removal space or service clearance areas. Do not install within 3'-0" clearance of electrical panel fronts.

3.08 RECESSES

- A. Furnish information to the general contractor as to sizes and locations of recesses required to install panels, boxes, grilles, and other equipment or devices which are to be recessed into walls.
- B. Make offsets or modifications as required to suit final locations.

3.09 EQUIPMENT SETTING

- A. Furnish and install as a minimum, a 4" thick concrete pad beneath all floor mounted equipment in mechanical rooms, or equipment rooms, or outside on grade.
- B. Furnish and install as a minimum, spring vibration isolators under any equipment 5 HP and over and rubber-in-shear vibration isolation under all equipment less than 5 HP. This shall apply to residential installations.
- C. Reinforce concrete with No. 4 rods 12" on centers both ways.
- D. Pad to have 3/4" dowels into concrete at 1 per 4 square feet.

3.10 LABELING

- A. All equipment, panels, controls, safety switches, and devices shall be provided with permanent black laminated white core labels with 3/8" letters.
- B. This shall also apply to all controllers, remote start/stop push buttons, equipment cabinets, and where directed by the A/E.
- C. This shall not apply to local room thermostats and light switches.

3.11 FLASHING AND COUNTERFLASHING

- A. Piping and conduit through the roof shall be flashed by the General Contractor. This contractor shall furnish counterflashing.
- B. Ductwork through the roof and roof mounted duct connected equipment shall be provided with prefabricated roof curbs. General contractor shall flash. This contractor shall counterflash.
- C. Structural dunnage for roof mounted equipment shall be flashed and counterflashed. Prefabricated roof curbs may be utilized.

3.12 ACCESS

- A. Locate all equipment, valves, devices, and controllers which may need service in accessible places.
- B. Where access is not available; access panels shall be provided. Furnish prime painted steel access doors to the General Contractor for installation.
- C. Access doors shall be 16 gauge frames and 22 gauge steel door. Access doors in fire rated walls shall have a "B" label for 1 ½ hours.
- D. Maintain clearances for tube removal, coil pulls, and filter removal.

3.13 WIRING

- A. Power wiring shall be provided by the Division 26 Electrical Contractor. This contractor shall furnish all 3 phase starters, pushbuttons, and controllers necessary to operate the equipment. The Electrical Contractor shall store and install the electrical devices and furnish and install the power wiring.
- B. Control wiring shall be furnished and installed under Division 23 portion of the work. Wiring for controls is control wiring whether it is line voltage or low voltage.
- C. All wiring shall be in accordance with the NEC.
- D. Pushbuttons shall be maintain-contact type.
- E. Refer to the electrical specifications for wiring methods.
- F. Plenum rated cable is required for control wiring.

3.14 UTILITIES

- A. Do not interrupt any utility or service without adequate previous notice and scheduling with the owner.
- B. Refer to Division 1 for requirements for providing temporary utilities.

3.15 CUTTING AND PATCHING EXTERIOR SERVICES

- A. This contractor shall be responsible for returning disturbed areas to original condition where excavation for utilities has been required.
- B. Cut and patch paved areas to match original surfaces.
- C. Properly tamp backfill before finishing surfaces.
- D. Concrete pavements and curbs shall be formed and poured to match adjacent areas.
- E. Grass areas shall be sodded and maintained until established growth is achieved.

3.16 GUARANTEE

- A. All work shall be guaranteed to be free from defects for a period of one year of operation from date of acceptance by the owner unless otherwise specified. Material and labor for first year warranty is to be provided.
- B. Guarantee shall be extended for all non-operational periods due to failure within the guarantee period.
- C. Compressors and refrigeration system components shall be provided with a 5 year factory warranty. Material only for years 2 through 5 is required.

3.17 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver material and equipment in manufacturer's original cartons or on skids.
- B. Store material in dry enclosures or under protective coverings out of way of work progress.
- C. Handle so as to prevent damage to product or any surrounding material.

3.18 MANUFACTURERS' NAMES

- A. Manufacturers' names are included herein to establish those suppliers who may provide products for this project subject to the requirements of the specifications. Although a manufacturer's name may appear as an acceptable supplier it is not understood that a standard product is acceptable. Products must also meet the technical, performance, and physical requirements of the project as well as being named in the specification. Any deviations from this must be acknowledged at bid time by the supplier and he shall be solely responsible for any and all costs associated with the application of his product in the project.
- B. A design cannot be prepared which accommodates the installation of all suppliers and is not intended to do so. If certain modifications must be made to accommodate one particular supplier's equipment it shall be considered the contractor's responsibility to arrange for such accommodations and be financially responsible for same.

3.19 AS-BUILT DRAWINGS

- A. At the completion of the work the contractor shall furnish a reproducible as-built drawings to the A/E for approval. The drawings shall indicate all work installed and its actual size and location. If acceptable, the A/E will submit the as-built drawings to the owner as record drawings. If not acceptable, the A/E will return the drawing to the contractor to make

corrections as required. The contractor will resubmit for approval.

- B. The as-built drawings shall indicate measured dimensions of underground lines and other concealed work.

3.20 PENETRATION SEALING

- A. All penetrations of fire walls, smoke walls, and floors by ducts, pipes, conduit, or wiring shall be sealed to prevent the flow of gases or smoke.
- B. The sealant shall be foamed in place between the penetrant and the adjacent floor or wall with DOW Corning RTV foam or equivalent by 3M, Hilti, or Chase foam.
- C. The installation shall meet the approval of the authority having jurisdiction.
- D. Penetrations through rated surfaces shall have a UL rating equivalent to the adjacent surfaces.
- E. All other penetrations of walls either above ceilings or exposed shall be closely sealed around the penetration with caulking or packing to prevent flow of air or sound through the wall.

3.21 CUTTING AND PATCHING INTERIOR SURFACES

- A. Respective contractor shall install all hangers, supports, pipe sleeves in floors, walls, partitions, ceilings, and roof slabs as construction progresses to permit their work to be built into place and to eliminate unnecessary cutting of construction work.
- B. All cutting of concrete, or other material for the passage of piping and ductwork through floors, walls, partitions, and ceiling shall be done by the respective contractor where necessary to install his work. Respective contractor will close all such openings around piping, ductwork, and conduit with materials equivalent to that removed. All exposed surfaces shall be left in suitable condition for refinishing without further work.
- C. Contractor shall patch and repair any existing openings created by the demolition work in floors, walls, partitions, and ceilings not being reused for the new construction.

3.22 INVERTS AND ELEVATIONS

- A. Indicated inverts and elevations of existing utilities are approximate and based on the best information available.
- B. Upon award of contract, contractor shall verify in the field all such information and report any discrepancies before proceeding with work. Contractor shall be responsible for extra work caused by his failure to verify inverts and elevations.

3.23 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

- A. Furnish and install final connections to equipment furnished in other parts of the specification or furnished by the owner. Provide drainage connections, vent connections, water connections, fuel gas connections, duct connections, gas connections to the fixtures or equipment. Plumbing connections shall include valved supplies and trapped waste connections.

3.24 CONNECTIONS TO EXISTING SYSTEMS

- A. The contractor shall be responsible for connecting new systems to existing systems.
- B. Arrange for outages with the owner.
- C. Contractor shall shut down and drain existing systems.

- D. Contractor shall cut in, weld, solder, or thread, and make connections compatible with existing systems.
- E. Provide new valves at connections to existing systems.
- F. Contractor shall refill existing and fill new systems.
- G. Contractor shall purge air from systems, both new and existing.
- H. Contractor shall place existing systems back into operation.
- I. Contractor shall repair and replace any insulation damaged or removed during connection procedures.

3.25 COORDINATION DRAWINGS

- A. Provide 3/8" = 1'-0" scale drawings showing all coordinated ductwork, piping, conduit, and equipment of all trades.
- B. The sheet metal shop drawings may be used as the basis of these drawings.
- C. Show ductwork, walls, beams, steel, drainage piping, domestic water piping, HVAC piping, sprinkler piping, light fixtures, electrical conduit, and equipment.
- D. Contact other disciplines and obtain information to identify fully coordinated systems.
- E. Submit for review and approval to the A/E.
- F. Provide all dimensional data and necessary clearances to other trades for installation of fixtures and equipment within casework and counter tops.
- G. Work shall not proceed until coordination is completed and all conflicts, issues, sequences etc., are resolved.

3.26 WELDING

- A. All electric power for arc welding shall be supplied by the contractor performing the work.

3.27 VEHICLES

- A. Vehicle access to the site will be as directed by the owner.

3.28 RUBBISH DISPOSAL

- A. Burning of debris on the site shall not be permitted. All debris, refuse, and waste shall be removed from the premises at regular intervals. No accumulation shall be permitted.

3.29 PROTECTION

- A. Maintain all public walks and access ways.
- B. Erect and maintain barricades, warning signs, and other protective means as may be directed by the owner for protection of all persons and property from injury or damage.

3.30 SCAFFOLDING

- A. The contractor shall at his own expense, install, operate, protect, and maintain temporary services such as scaffolding, material hoists, access walks, etc., as may be required.

3.31 UTILITIES

- A. The contractor may use the existing water and electric power for temporary construction needs.

- B. The owner will direct where these services may be tapped.
- C. Those services that are used during construction, but are to remain, shall be refurbished to as new condition before turning back to the owner.

3.32 CLEANUP

- A. Remove all visible temporary tags or labels as well as any protective coverings and wrappings from fixtures and equipment.
- B. Remove all spots, stains, soil, paint, spackle, and other foreign matter from all finished work.
- C. Clean and polish all plumbing fixtures.
- D. Remove all trash and debris from the premises.

3.33 MOUNTING HEIGHTS

- A. Contractor to coordinate all mounting heights with all trades and architect prior to rough-in.
- B. Maximum thermostat mounting height (top of thermostat) in accordance with ADA.
 - 1. Side reach: 48" A.F.F.
 - 2. Forward reach: 48" A.F.F.

3.34 WORK COMPLETION

- A. The contractor shall promptly correct work rejected by the engineer failing to conform to the requirements of the contract documents, whether discovered before or after substantial completion and whether or not fabricated, installed or completed. Costs of correcting such rejected work, including additional testing and inspections and compensation for the engineer's services and expenses made necessary thereby, shall be at the contractor's expense.

3.35 REQUEST FOR INFORMATION (RFI) REQUIREMENTS

- A. All RFI's shall include the following information based on AIA Document G716:
 - 1. To, From, Project Name, Issue Date, RFI number in sequential order with all other trades, Requested Reply Date.
 - 2. Provide a description with specification and/or drawing references.
 - 3. Provide the senders recommendation including cost and/or schedule considerations.
 - 4. Provide receiver's reply space.
 - 5. Note an RFI reply is not an authorization to proceed with the work involving additional cost/time.

3.36 SHOP DRAWING REQUIREMENTS

- A. The following is a list of required shop drawings for the project. Not all items may be identified, and it is the responsibility of the contractor to submit additional shop drawings where indicated in the specifications.

HVAC	DATE REC'D	ACTION	DATE REC'D	ACTION
COORDINATION DRAWINGS				
PIPING				

HVAC	DATE REC'D	ACTION	DATE REC'D	ACTION
VIBRATION ISOLATION				
INSULATION A. Piping B. Ductwork				
SHEET METAL DRAWINGS				
UNIT HEATERS				
CONVECTORS (ELECTRIC)				
FANS				
HEAT PUMPS				
ROOFTOP UNITS				
SPLIT SYSTEMS				
VAV UNITS				
VAV TERMINALS				
FURNACES				
FIRE DAMPERS/RADIANT DAMPERS				
VOLUME DAMPERS				
SMOKE DAMPERS				
GRILLES, REGISTERS, DIFFUSERS				
LOUVERS/ROOF CAPS				
EQUIPMENT CURBS				
AUTOMATIC TEMPERATURE CONTROL A. DEVICES B. WIRING DIAGRAMS C. SEQUENCES				
TEST, BALANCE AND ADJUST REPORT				
AS-BUILT DRAWINGS				
WARRANTIES AND GUARANTEES				
OPERATIONS AND MAINTENANCE MANUALS				
INSTRUCTIONS				

HVAC	DATE REC'D	ACTION	DATE REC'D	ACTION
EMERGENCY AND MANUFACTURER CONTACTS				
CONDENSATE PUMPS				

END OF SECTION

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small, and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.02 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.

1.03 SUBMITTALS

- A. Shop drawing submittals for motorized equipment shall include, but not limited to, the following information on motors provided with equipment.
 - 1. Manufacturer's name and cutsheets.
 - 2. Motor type.
 - 3. Horsepower.
 - 4. Voltage/Phase/Hertz.
 - 5. RPM.
 - 6. Service factor.
 - 7. Insulation class.
 - 8. NEC code number.
 - 9. Motor efficiency and testing method and results.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. All materials and equipment furnished shall be installed as per manufacturer's requirements and conform to the requirements of Division 26.

2.02 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg. C and at altitude of 3300 feet above sea level.

- B. 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. Incorporate latest IEEE and NEMA standards.
- D. All copper windings with ball bearings.
- E. Indoors; drip proof, 40 degree C rise.
- F. Outdoors; totally enclosed 55 degree C rise.
- G. Motors over 10 HP to be high efficiency with PF in excess of 0.9.

2.03 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. 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.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. 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.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.05 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp. shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.

- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. 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 shall automatically reset when motor temperature returns to normal range.

2.06 MOTOR STARTERS

- A. Fractional with horsepower up to ½ HP; electrical contract.
- B. Polyphase and single phase above ½ HP: this contract.
- C. Electrical contractor shall install all starters except for those provided as an integral part of equipment.
- D. Polyphase starters shall be magnetic combination type, across-the-line electrically operated, electrically held, three pole assemblies, with arc extinguishing characteristics, silver to silver renewable contacts, 3 pole thermal bi-metallic, red run pilot light, individual phase protection, with overload heaters matched to motors installed and with 4 auxiliary contact, Hand-off-Auto switch, and control transformer.
- E. For single phase motors above ½ HP provide magnetic combination single phase motor starters with overloads, non-fusible disconnect switch, red run pilot light, integral 120 volt control transformer with dual primary fusing auxiliary contacts.
- F. Starters shall be as manufactured by G. E., Siemens, Square "D", Cerus or Cutler-Hammer.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Motors shall be leveled, set in true angular and concentric alignment with driven equipment, and bolted firmly to motor base, if not mounted on equipment. Motors's factory-mounted on equipment shall be checked for alignment to driven equipment and mounting bolts shall be checked to ensure bolts are tightly fastened.
- B. Coordination: The Mechanical Contractor shall have the responsibility to provide adequate rough-in information to the Electrical Contractor. Any costs, such as patching and refinishing of walls, resulting from inadequate information shall be the responsibility of the Mechanical Contractor.
- C. For variable frequency drives, refer to Specification 23 09 93.

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.
 - 5. Equipment supports.

1.02 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 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].

1.03 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. 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.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.05 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

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
- D. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.02 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop or field fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.04 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: 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. Mechanical-Expansion Anchors: Insert wedge type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate

for supported loads and building materials where used.

2.05 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.06 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-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

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal 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 the building structure.
- B. Metal 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 for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. 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.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. 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-inch 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.

- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- 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. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4-inch 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-inch and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4-inch to NPS 2 1/2 -inch: 12 inches long and 0.048 inch thick.
 - b. NPS 4-inch: 12 inches long and 0.06 inch thick.
 - c. NPS 5-inch and NPS 6-inch: 18 inches long and 0.06 inch thick.
 - d. NPS 8-inch to NPS 14-inch: 24 inches long and 0.075 inch thick.
 - e. NPS 16-inch to NPS 24-inch: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8-inch 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 same thickness as piping insulation.

3.02 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.

3.03 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.

3.04 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 ½ inches.

3.05 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are 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 carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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-inch to NPS 30-inch.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg. F, pipes NPS 4-inch to NPS 24-inch, 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-inch to NPS 36-inch, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2-inch to NPS 8-inch.

5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2-inch to NPS 30-inch.
 6. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4-inch to NPS 36-inch, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 7. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4-inch to NPS 36-inch, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 8. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1-inch to NPS 30-inch, from two rods if longitudinal movement caused by expansion and contraction might occur.
 9. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2-inch to NPS 42-inch if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
- 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-inch to NPS 24-inch.
 2. Carbon or Alloy Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4-inch to NPS 24-inch if longer ends are required for riser clamps.
- K. 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.
- L. 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. 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.
 8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- M. 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.

- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1 ¼ inches.
 - 2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 - 3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 48.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads
 - 2. Elastomeric isolation mounts
 - 3. Open-spring isolators
 - 4. Pipe-riser resilient support
 - 5. Resilient pipe guides
 - 6. Spring hangers
 - 7. Duct hangers
 - 8. Equipment frame bases
 - 9. Equipment rail bases
 - 10. Roof curb bases

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each vibration isolation device.
 - 1. Include design calculations for selecting vibration isolators.

PART 2 - PRODUCTS

2.01 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 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. Infused nonwoven cotton or synthetic fibers.
 - 7. Load-bearing metal plates adhered to pads.
 - 8. Application: Floor mounted furnaces and A/C units of 2000 CFM or less. Roof mounted condensing units up to 5 tons shall be mounted on curbs with neoprene pads. See spring mounts for over 5 tons.

2.02 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 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.
 4. Application: Base mounted pumps up to 5 Hp slab on grade, air handling units' slab on grade.

2.03 OPEN SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 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.
 8. Application: Base mounted pumps not slab on grade and less than 5 Hp, base mounted pumps slab on grade 7 ½ HP and up. Air handling units not slab on grade. Roof mounted condensing units over 5 tons cooling capacity.

2.04 PIPE-RISER RESILIENT SUPPORT

- A. Description: 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.

2.05 RESILIENT PIPE GUIDES

- A. Description: 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.

2.06 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 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.
 10. Application: Below 5 ton horizontal suspended fan terminal units, in-line exhaust fans.

2.07 EQUIPMENT FRAME BASES

- A. Vibration isolator manufacturer shall furnish integral structural steel bases. Bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of one inch.
- B. Bases shall be type WF as manufactured by Mason Industries, Inc. or equivalent by Vibration Eliminator Company or Amber Booth.
- C. Application: Special use where structural rigidity required between components.

2.08 EQUIPMENT RAIL BASES

- A. Vibration isolator manufacturer shall provide steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary rigid to prevent strains in the equipment.
- B. Inverted saddles shall be type ICS as manufactured by Mason Industries, Inc. or equivalent by Vibration Eliminator Company or Amber Booth.

- C. Application: Base mounted HVAC units.

2.09 ROOF CURB BASES

- A. Curb mounted rooftop equipment shall be mounted on vibration isolation bases that fit over the roof curb and under the isolated equipment. The extruded aluminum top members shall overlap the bottom member to provide water runoff independent of the seal. The aluminum member shall house cadmium plated springs having a 1 inch, 2 inch minimum deflection with 50% addition travel to solid. Spring diameters shall be no less than 0.8 of the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4" so as not to interfere with the spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible duct like connection joining the outside perimeter of the aluminum members. Foam or other contact like seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum.
- A. HUSHCORE® DECK™ System In-Curb Multi-Layer Acoustical Treatment
1. HUSHCORE® DECK™ system shall be multiple layers installed to meet the following acoustical performance. Materials shall meet Class "A" for flammability as per ASTM E-84 test procedures.

HUSHCORE In-Curb Composite - (Transmission Loss) in accordance with ASTM E-90-10																			
Freq. (Hz)	80	100	125	160	200	250	315	400	500	630	800	1K	1.25K	1.6K	2K	2.5K	3.15K	4K	5K
Transmission Loss (dB)	18	23	34	36	43	45	51	55	57	60	60	62	64	67	66	66	71	74	76
	6.3K	8K	STC																
	78	81	57																

2. Decking shall be maintained inside the curb to a clearance of 1/4" maximum around all duct drops but may never contact the duct.
 3. Total thickness shall not exceed 10" for all in-curb layers.
 4. HUSH SEALANT™ HSAC-100 shall be used in the following areas.
 - a. Around the entire curb interior perimeter
 - b. Around duct drop penetrations of the decking
 - c. Sealant shall be an acoustical grade, non-hardening formulation.
- B. Curb mounted bases shall be type CMAB as manufactured by Mason Industries or equivalent by Vibration Eliminator Company, Amber Booth, Thi-Curb, Custom Curb or R.P.S.
- C. Application: Roof mounted A/C units, air handling units and separated condensing units.

PART 3 - EXECUTION

3.01 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 Architectural specification sections.

- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Select the appropriate base to match the equipment being provided. Base shall meet the exact dimensional and weight requirements at all points of the curb. Install as recommended by the vibration isolator manufacturer.

END OF SECTION

SECTION 23 05 50 - FIRE STOPPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Refer to Section 23 05 00 for requirements which are applicable to this section.
- B. Refer to International Building Codes.
- C. Section includes.
 - 1. Through penetration firestops and smoke-stops for all fire rated bearing and non-bearing wall and floor assemblies, both blank (empty) and those accommodating penetrating items such as cables, conduits, pipes, ducts, etc.

1.02 REFERENCES

- A. American Society for Testing and Materials Standards (ASTM):
 - 1. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E814: Standard Test method for Fire Tests of Through-Penetration Firestops.
- B. Underwriters Laboratories, Inc.:
 - 1. UL 723 Surface Burning Characteristics of Building Materials
 - 2. UL 1479 Fire Tests of Through-Penetration Firestops.
- C. UL Fire Resistance Directory:
 - 1. Through Penetration Firestop Devices (XHJI)
 - 2. Fire Resistive Ratings (BXUV)
 - 3. Through Penetration Firestop Systems (XHEZ)
 - 4. Fill, Void, or Cavity Material (XHHW)

1.03 DEFINITIONS

- A. FIRESTOPPING: The use of a material or combination of materials in a fire rated structure (wall or floor) where it has been breached, so as to restore the integrity of the fire rating on that wall or floor.
- B. SYSTEM: The use of a specific firestop material or combination of materials in conjunction with a specific wall or floor construction type and a specific penetrant(s), constitutes a "System."
- C. BARRIER: Any bearing or non-bearing wall or floor that has an hourly fire and smoke rating.
- D. THROUGH-PENETRATION: Any penetration of a fire rated wall or floor that completely breaches the barrier.
- E. MEMBRANE-PENETRATION: Any penetration in a fire rated wall that breaches only one side of the barrier.
- F. CONSTRUCTION GAPS: any gap, joint, or opening, whether static or dynamic, where the top of a wall may meet a floor; wall to wall applications; edge to edge floor configurations; floor to exterior wall; or any linear breach in a rated barrier. Where movement is required, the firestopping system must comply with UL2079 for dynamic joints.

1.04 SUBMITTALS

NOTE: A "Certificate of Conformance," from the manufacturers listed in Section "2.02 Acceptable Manufacturers," is required with the "Submittal Package" to ensure that the material selected meets all of the criteria of this specification as set forth in Section "1.05 Quality Assurance."

- A. Submit manufacturer's product literature for each type of firestop material to be installed. Literature shall indicate product characteristics, typical uses, performance and imitation criteria, and test data. Submittal should be in compliance with Section 23 05 00.
- B. Material Safety Data Sheets (MSDS): Submit MSDS for each firestop product.
- C. UL Tested Systems: Submit drawings showing typical installation details for the methods of installation. Indicate which firestop materials will be used and thickness for different hourly ratings.
- D. Engineering Judgments: Submit manufacturer's drawings for all non-standard applications where no UL tested system exists. All drawings must indicate the "Tested" UL system upon which the judgment is based so as to assess the relevance of the judgment to some known performance.
- E. Submit manufacturer's installation procedures for each type of product.
- F. Approved Applicator: Submit document from manufacturer wherein manufacturer recognizes the installer as qualified or submit a list of past projects to demonstrate capability to perform intended work.
- G. Upon completion, installer shall provide written certification that materials were installed in accordance with the manufacturer's installation instructions and details.

1.05 QUALITY ASSURANCE

- A. Firestopping systems (materials and design):
 - 1. Shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire tests in a configuration that is representative of field conditions.
 - 2. The F rating must be minimum of one (1) hour but not less than the fire resistance rating of the assembly being penetrated. T rating when required by code authority shall be based on measurement of the temperature rise on penetrating item(s). The fire test shall be conducted with a minimum positive pressure differential of 0.01 inches of water column joints, must be tested to UL 2079 with movement capabilities equal to those of the anticipated conditions.
- B. Firestopping materials and systems must be capable of closing or filling through openings created by 1) the burning or melting of combustible pipes, cable jacketing, or pipe insulation materials, or 2) deflection of sheet metal due to thermal expansion (electrical & mechanical duct work).
- C. Firestopping material shall be asbestos and lead free and shall not incorporate nor require the use of hazardous solvents.
- D. Firestopping sealants must be flexible, allowing for normal pipe movement.
- E. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.
- F. Firestopping materials shall be moisture resistant, and may not dissolve in water after curing.
- G. All firestopping materials shall be manufactured by one manufacturer (to the maximum extent possible).
- H. Installation of firestopping systems shall be performed by a contractor (or contractors) trained or approved by the firestop manufacturer.
- I. Material used shall be in accordance with the manufacturer's written installation instructions.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver material in the manufacturer's original, unopened containers or packages with the manufacturer's name, product identification, lot number, UL label and mixing and installation instructions as applicable.
- B. Store materials in the original, unopened containers or packages and under conditions recommended by the manufacturer.
- C. All firestop materials will be installed prior to expiration of shelf life.

1.07 PROJECT CONDITIONS

- A. Conform to manufacturer's printed instructions for installation and when applicable, curing in accordance with temperature and humidity. Conform to ventilation and safety requirements.
- B. Verify the condition of the substrates before starting work.
- C. Weather Conditions: Do not proceed with installation of firestop materials when temperatures fall outside the manufacturer's suggested limits.
- D. Care should be taken to ensure that firestopping materials are installed so as not to contaminate adjacent surfaces.

1.08 SEQUENCING

- A. Schedule firestopping after installation of penetrants but prior to concealing the openings.
- B. Firestopping shall precede gypsum board finishing.

1.09 PROTECTION

- A. Where firestopping is installed at locations which will remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Firestopping materials and systems shall meet the requirements specified herein.
- B. Architect must approve in writing any alternates to the materials and system specified herein.
- C. All firestop products and systems shall be designed and installed so that the basic sealing system will allow the full restoration of the thermal and fire resistance properties of the barrier being penetrated with minimal repair if penetrants are subsequently removed.
- D. For applications where combustible penetrants are involved, i.e., insulated, and plastic pipe, a suitable intumescent material must be used.

2.02 ACCEPTABLE MANUFACTURERS

NOTE: Inclusion of materials in this specification does not indicate that the listed products

have been evaluated for conformance to this specification. Therefore, the user/contractor must certify in the submittal package, with a "Certificate of Conformance" from the manufacturers listed below, that the material selected meets all of the criteria set forth in Section "1.05 Quality Assurance" of this specification.

- A. Specified Technologies, Inc./GE Pensil® (STI), Somerville, NJ 08876, Phone: (800) 992-1180.
- B. 3M Fire Protection Products, St. Paul, MN

2.03 MATERIALS

- A. Intumescent Firestop Sealants and Caulks:
 - 1. STI SpecSeal SSS100
 - 2. 3M Fire Barrier Caulk CP25WB+
- B. Latex Firestop Sealant
 - 1. STI SpecSeal LC150 Sealant
- C. Elastomeric Water-Based Sealant
 - 1. STI SpecSeal ES100 Elastomeric Sealant
- D. Silicone Firestop Sealants and Caulks:
 - 1. STI SpecSeal Pensil 300\
 - 2. 3M Fire Barrier Silicone Sealants
- E. Firestop Putty:
 - 1. STI SpecSeal Firestop Putty Bars and Pads
 - 2. 3M Fire Barrier Moldable Putty
- F. Firestop Collars:
 - 1. STI Spec Seal Firestop Collars
 - 2. 3M Fire Barrier PPD's.
- G. Wrap Strips:
 - 1. SpecSeal Wrap Strip
 - 2. 3M Fire Barrier FS195 Wrap Strip.
- H. 2-Part Silicone Firestop Foam:
 - 1. STI SpecSeal Pensil 200
 - 2. 3M Fire Barrier 2001 Silicone Foam.
- I. Firestop Mortar:
 - 1. STI SpecSeal Mortar.
- J. Firestop Pillows:
 - 1. STI SpecSeal Pillows
- K. Elastomeric Spray:
 - 1. STI SpecSeal AS Elastomeric Spray
- L. Composite Board:
 - 1. 3M Barrier Sheet Material
- M. Accessories:

2.04 Forming/Damming Materials: Mineral fiberboard or other type as per manufacturer recommendation.

PART 3 - CONDITIONS REQUIRING FIRESTOPPING

3.01 General:

- A. Provide firestopping for conditions specified whether or not firestopping is indicated, and if indicated, whether such material is designed as insulation, safing, or otherwise.
- B. Through-Penetrations:
 - 1. Firestopping shall be installed in all open penetrations and in the annular space in all penetrations in any bearing or non-bearing fire-rated barrier.
- C. Membrane-Penetrations:
 - 1. Where required by code, all membrane-penetrations in rated walls shall be protected with firestopping products that meet the requirements of third party time/temperature testing.
- D. Construction Joints/Gaps:
 - 1. Fire Stopping shall be provided:
 - a. Between the edges of floor slabs and exterior walls.
 - b. Between the tops of walls and the underside of floors
 - c. In the control joint in masonry walls and floors
 - d. In expansion joints.
- E. Smoke-Stopping:
 - 1. As required by the other Sections, Smoke-Stops shall be provided for Through-Penetrations, Membrane-) Penetrations, and Construction Gaps with a material approved and tested for such application.

3.02 EXAMINATION

- A. Examine the areas and conditions where firestops are to be installed and notify the architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected by the contractor in a manner acceptable to the architect and in accordance with Section 01039.
- B. Verify that environmental conditions are safe and suitable for installation of firestop products.
- C. Verify that all pipe, conduit, cable, and other items which penetrate fire-rated construction have been permanently installed prior to installation of firestops.

3.03 INSTALLATION

- A. General:
 - 1. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
 - 2. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
 - 3. Unless specified and approved, all insulation used in conjunction with through-penetrants shall remain intact and undamaged and may not be removed.
 - 4. Seal holes and penetrations to ensure an effective smoke seal.
 - 5. In areas of high traffic, protect firestopping materials from damage. If the opening is large, install firestopping materials capable of supporting the weight of a human.
 - 6. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
 - 7. All combustible penetrants (e.g., Non-metallic pipes or insulated metallic pipes) shall be fire stopped using products and systems tested in a configuration representative of the field condition.
- B. Dam Construction: When required to properly contain firestopping materials within openings damming or packing materials may be utilized. Combustible damming material

must be removed after appropriate curing. Non-combustible damming materials may be left as a permanent component of the firestop system.

3.04 FIELD QUALITY CONTROL

- A. Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.
- B. Follow safety procedures recommended in the Material Safety Data Sheets.
- C. Finish surfaces of firestopping which are to remain exposed in the completed work to a uniform and level condition.
- D. All areas of work must be accessible until inspection by the applicable Code Authorities.
- E. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification.

3.05 CLEANING

- A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surfaces.
- B. Leave finished work in neat, clean condition with no evidence of spill overs or damage to adjacent surfaces.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.

1.02 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Seton Identification Products.
 - 2. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 3. Letter Color: Black.
 - 4. Background Color: White.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2 ½ by ¾ 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-quarters the size of principal lettering.
 - 7. Fasteners: Stainless-steel self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with

- substrate.
- B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Carlton Industries, LP.
 - d. Champion America.
 - e. Craftmark Pipe Markers.
 - f. emedco.
 - g. Kolbi Pipe Marker Co.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Seton Identification Products.
 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 3. Letter Color: Black.
 4. Background Color: White.
 5. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
 6. Minimum Label Size: Length and width vary for required label content, but not less than 2 ½ by 3/4 inch.
 7. 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-quarters the size of principal lettering.
 8. Fasteners: Stainless-steel self-tapping screws.
 9. 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.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8 ½ by 11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Carlton Industries, LP.
 4. Champion America.
 5. Craftmark Pipe Markers.
 6. emedco.
 7. LEM Products Inc.
 8. Marking Services Inc.
 9. National Marker Company.
 10. Seton Identification Products.

11. Stranco, Inc.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - C. Letter Color: Black.
 - D. Background Color: White
 - E. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
 - F. Minimum Label Size: Length and width vary for required label content, but not less than 2 ½ by ¾ inch.
 - G. 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-quarters the size of principal lettering.
 - H. Fasteners: Stainless-steel self-tapping screws.
 - I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
 - J. Label Content: Include caution and warning information plus emergency notification instructions.

2.03 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP.
 - 5. Champion America.
 - 6. Craftmark Pipe Markers.
 - 7. emedco.
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Services Inc.
 - 11. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover 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 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: Size letters according to ASME A13.1 for piping. At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.04 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the

following:

1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Carlton Industries, LP.
 4. Champion America.
 5. Craftmark Pipe Markers.
 6. emedco.
 7. Kolbi Pipe Marker Co.
 8. LEM Products Inc.
 9. Marking Services Inc.
 10. Seton Identification Products.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: White.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2 ½ by 3/4 inch.
- G. 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-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

PART 3 - EXECUTION

3.01 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.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting." Section 099600 "High-Performance Coatings."

- B. 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. 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 and on both sides of 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 areas of congested piping and equipment.
- C. Pipe Label Color Schedule:
 - 1. Refrigerant Piping: Black letters on a safety-orange background.

3.04 DUCT LABEL INSTALLATION

- A. Install plastic-laminated self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Green: For exhaust, and outside air ducts.
- B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.

1.02 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 independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.

1.03 INFORMATIONAL SUBMITTALS

- A. Certified TAB reports.

1.04 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC or NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC or NEBB as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 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 installed systems for 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 applicable for intended purpose and 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 ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
 - F. 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.
 - G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
 - H. Examine test reports specified in individual system and equipment Sections.
 - I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
 - J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
 - K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
 - L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
 - M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
 - N. Examine system pumps to ensure absence of entrained air in the suction piping.
 - O. Examine operating safety interlocks and controls on HVAC equipment.
 - P. 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.

3.02 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures for balancing the systems.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Duct systems are complete with terminals installed.
 - b. Volume, smoke, and fire dampers are open and functional.
 - c. Clean filters are installed.
 - d. Fans are operating, free of vibration, and rotating in correct direction.
 - e. Variable-frequency controllers' startup is complete, and safeties are verified.

- f. Automatic temperature-control systems are operational.
- g. Ceilings are installed.
- h. Windows and doors are installed.
- i. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- 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 Section 233300 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping 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.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check 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 Section 233113 "Metal Ducts."
- M. The contractor shall allow for (2) passes for each heating and cooling season.
- N. Allow for one sheave change for 50% of the HVAC systems to be tested and adjusted. Replacement sheave shall be furnished and installed by the mechanical contractor. Sheave shall be adjusted by the TBA contractor.

3.05 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. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. 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.
 4. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 5. 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 occurs. 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.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.

3.06 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 2. Verify that the system is under static pressure control.
 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-

- unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside air, return air, and relief air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
 7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
 8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the

system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.

9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.07 ENERGY RECOVERY UNIT TEST

- A. Tests shall substantiate:
 1. CFM of supply and exhaust.
 2. Winter BTU exchange, sensible and latent grains.
 3. Summer BTU exchange, sensible and latent grains.
 4. Quantitative CFM of cross flow from higher pressure to lower pressure side of wheel. Percent of total flow.
- B. Compare measured values to required values and tabulate.

3.08 DUCTWORK LEAKAGE TESTING

- A. Installed ductwork shall be tested prior to installation of access doors, take-offs, etc.
- B. All leak testing shall be witnessed by the engineer or representative of the engineer. The contractor shall give the engineer 72 hours' notice prior to testing. Any testing not witnessed by the engineer or his/her representative shall be considered invalid and will be redone.
- C. The testing shall be performed as follows:
 1. Perform testing in accordance with HVAC Air Duct Leakage Test Manual.
 2. Use a certified orifice tube for measuring the leakage.
 3. Determine section of system to be tested and blank off.
 4. Determine the percentage of the system being tested.
 5. Using that percentage, determine the allowable leakage (cfm) for that section being tested.
 6. Pressurize to operating pressure and repair any significant or audible leaks.
 7. Repressurize the measure leakage.
 8. Repeat steps 6 and 7 until the leakage measured is less than the allowable defined in step 5.

NOTE: It is recommended that the first 100'-300' of ductwork installed be tested to insure the quality of the workmanship at an early stage.

3.09 TOLERANCES

- A. Set HVAC system's airflow 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.

- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.10 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.
 3. Certify validity and accuracy of field data.
- 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 specialist.
 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. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Duct, outlet, and inlet sizes.
 3. Terminal units.
 4. Balancing stations.
 5. 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 airflow 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. 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. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg. F.
- G. System-Coil Reports: For reheat 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.
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-air temperature in deg. F.
 - c. Leaving-air temperature in deg. F.
- H. Instrument Calibration Reports:
- 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.11 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.
- B. Construction Manager 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.
- C. If 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."
- D. 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.
- E. If TAB work fails, proceed as follows:
 - 1. TAB specialists shall 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 specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 - 3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.

3.12 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.
- 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

SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Outdoor, concealed supply and return.
 - 6. Outdoor, exposed supply and return.
- B. Related Sections:
 - 1. Section 230719 "HVAC Piping Insulation."
 - 2. Section 233113 "Metal Ducts" for duct liners.
- C. Insulation to be in accordance with ASHRAE 90.1-2016.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties, and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Install insulation in accordance with the manufacturer's instructions.
- B. Material Certifications: Manufacturers can provide information regarding material and testing certifications from a qualified testing agency acceptable to authorities having jurisdiction (AHJ). The AHJ can use this information for indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. (Many companies published compliance data on public data sheets while also offering technical resources for additional information. The wording was adjusted to reflect this.)
- C. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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 agency. Suggestion: or proper documentation indicating compliance. (Some

fabricated materials used by the industry do not come directly from the manufacturer, so this documentation can be provided in those cases).

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation 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. Products that come in contact with austenitic stainless steel operating at temperatures between 140°F and 250°F shall have a leachable chloride content in accordance with the limits set by ASTM C795 (Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel).
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795. See above.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. 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 I] Factory-applied jacket requirements are specified in "Factory-Applied Jackets"

Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA, or Type IB. For duct and plenum applications, provide insulation with factory applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.

2.02 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M.
 - b. CertainTeed Corporation.

2.03 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - 2. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - 2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Corning Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. P.I.C. Plastics, Inc.
 - d. Speedline Corporation.
 - 2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental

Chambers."

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. VOC Content: 420 g/L or less.
 - 2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Knauf Insulation.
 - c. Vimasco Corporation.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.

2.05 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - 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° F.
 - 5. Color: Aluminum.
 - 6. Sealant shall have a VOC content of 420 g/L or less.
 - 7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - 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° F.
 - 5. Color: White.
 - 6. Sealant shall have a VOC content of 420 g/L or less.
 - 7. Sealant shall comply with the testing and product requirements of the California

Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.06 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.
- B. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.07 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.

2.08 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White
- D. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. ITW Insulation Systems; Illinois Tool Works, Inc. Johns Manville
 - c. RPR Products, Inc.
 2. [Sheet and roll stock ready for shop or field sizing] [Factory cut and rolled to size].
 3. Finish and thickness are indicated in field-applied jacket schedules.

4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
5. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
- E. Self-Adhesive Outdoor Jacket: 6014-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with stucco-embossed aluminum-foil facing.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Polyguard Products, Inc.
 - b. VentureClad by 3M

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Venture Tape.
 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Venture Tape.
 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. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.

- e. Venture Tape.
- 2. Width: 2 inches.
- 3. Thickness: 3.7 mils.
- 4. Adhesion: 100 ounces' force/inch in width.
- 5. Elongation: 5 percent.
- 6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.
- 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc.
 - 4) Midwest Fasteners, Inc.
 - 5) Nelson Stud Welding.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Aluminum, 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Gemco.
 - 2) Midwest Fasteners, Inc.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1 ½ inches in diameter.
 - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2 ½ 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. Self-Sticking-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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc.
 - 4) Midwest Fasteners, Inc.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Aluminum, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
4. 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 ½ inches in diameter.
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc.
 - 4) Midwest Fasteners, Inc.
 - 5) Nelson Stud Welding.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 - c. 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 ½ inches in diameter.
 - d. Manufacturers: Subject to compliance with requirements, provide products by 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: 0.062-inch soft-annealed, galvanized steel.
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. C & F Wire.

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 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. Keep insulation materials dry during storage, application, and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. 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.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. 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 ½ inches. 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, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. 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.

3.03 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.
 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: 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 Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
1. Duct: 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. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.04 INSTALLATION OF MINERAL-FIBER INSULATION

- A. 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 100 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 one edge and one 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 two 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.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive, tape, or and insulation pins. Follow manufacturer's installation instructions.
- 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 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 one edge and one 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°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 two 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.

3.05 FIELD-APPLIED JACKET INSTALLATION

- A. 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 ½ -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.
- B. 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 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.
- C. 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.

3.06 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 Section 078413 "Penetration Firestopping."

3.07 FINISHES

- A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 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. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.
- D. Local building code and fire marshal shall approve before painting.

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections. Engage a qualified testing agency to perform tests and inspections.
- B. 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.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.09 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply, return and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Outdoor, concealed supply, return, locker room / shower exhaust.
 - 6. Outdoor, exposed supply, return, locker room / shower exhaust.
- B. Items Not Insulated:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 3. Factory-insulated flexible ducts.
 - 4. Factory-insulated plenums and casings.
 - 5. Flexible connectors.
 - 6. Vibration-control devices.
 - 7. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 0.75-lb/cu. Ft. nominal density. "R" value of 4.2.
- B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 0.75-lb/cu. Ft nominal density. "R" value of 4.2.
- C. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 0.75-lb/cu. Ft nominal density. "R" value of 4.2.

- D. Concealed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 0.75-lb/cu. Ft. nominal density. "R" value of 4.2.
- E. Exposed, Supply-Air Duct and Plenum Insulation:
 - 1. On Public spaces: internal acoustical lining, 1.5 inches thick. R value of 6.3. Johns Manville Linacoustic RC.
 - 2. On Back of the house areas: Mineral-fiber blanket, 2 inches thick and 3-lb/cu. ft. nominal density. "R" value of 4.2.
- F. Exposed, Return-Air Duct and Plenum Insulation:
 - 1. On Public spaces: internal acoustical lining, 1.5 inches thick. R value of 6.3. Johns Manville Linacoustic RC.
 - 2. On Back of the house areas: Mineral-fiber blanket, 2 inches thick and 3-lb/cu. ft. nominal density. "R" value of 4.2.
- G. Exposed, Outdoor-Air Duct and Plenum Insulation:
 - 1. On Public spaces: internal acoustical lining, 1.5 inches thick. R value of 6.3. Johns Manville Linacoustic RC.
 - 2. On back of the house areas: Mineral-fiber blanket, 2 inches thick and 3-lb/cu. ft. nominal density. "R" value of 4.2.
- H. Exposed, Exhaust-Air Duct and Plenum Insulation: Mineral-fiber blanket, 2 inches thick and 3-lb/cu. ft. nominal density. "R" value of 4.2.

3.11 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
 - 1. Concealed, Supply-Air Duct and Plenum Insulation: Mineral-fiber board 3 inches thick and 6-lb/cu. ft. nominal density. "R" value of 8.3.
 - 2. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber board, 3 inches thick and 6-lb./cu. ft. nominal density. "R" value of 8.3.
 - 3. Concealed, Outdoor-Air Duct and Plenum Insulation: Mineral-fiber board, 3 inches thick and 6-lb/cu. ft. nominal density. "R" value of 8.3.
 - 4. Exposed, Supply-Air Duct and Plenum Insulation: Mineral-fiber board, 3 inches thick and 6-lb/cu. ft. nominal density. "R" value of 8.3.
 - 5. Exposed, Return-Air Duct and Plenum Insulation: Mineral-fiber board, 3 inches thick and 6-lb/cu. ft. nominal density. "R" value of 8.3.

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. If more than one material is listed, selection from materials listed is Contractor's option.
 - 1. Ducts and Plenums, Concealed:
 - a. None.
 - 2. Ducts and Plenums, Exposed:
 - a. None.

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. If more than one material is listed, selection from materials listed is Contractor's option.

1. Ducts and Plenums, Concealed:
 - a. Aluminum, Smooth: 0.024 inch thick.
2. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches.
 - a. Aluminum: 0.024 inch thick.
3. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
 - a. Painted Aluminum, Smooth with 2 ½ -Inch Deep Corrugations: 0.040 inch thick.

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
 - 1. Section 230713 "Duct Insulation."

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of insulation product indicated, include thermal conductivity, water-vapor permeability for closed cell insulations, thickness, applicable ASTM standard specification, and jackets (both factory- and field-applied, if any). For each type of vapor retarder or jacket specified, include water vapor permeability, required thickness, and applicable ASTM standard specification.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 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.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.03 INFORMATIONAL SUBMITTALS (Only as necessary)

- A. Field quality-control reports.

1.04 QUALITY ASSURANCE

- A. Material Certifications: Manufacturers can provide information regarding material and testing certifications from a qualified testing agency acceptable to authorities having jurisdiction (AHJ). The AHJ can use this information for indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to 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 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.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. 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. Products that come in contact with austenitic stainless steel operating at temperatures between 140°F and 250°F shall have a leachable chloride content in accordance with the limits set by ASTM C795 (Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel).
- C. Insulation materials for use on austenitic stainless steel operating at temperatures between 140°F and 250°F shall be qualified as acceptable according to ASTM C 795. (Same reasoning as above)
- 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. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Pittsburgh Corning Corporation.
 - 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 Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- H. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.

- b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Manson Insulation Inc.
 - e. Owens Corning.
- J. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 - 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.
 - 3. Type II, 1200 deg. F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Owens Corning.

2.02 INSULATING CEMENTS

- A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ramco Insulation, Inc.

2.03 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: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg. F.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - 2. Adhesives shall have a VOC content of 50 g/L or less.
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. K-Flex USA.
 2. Adhesives shall have a VOC content of 50 g/L or less.
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 2. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Corning Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. P.I.C. Plastics, Inc.
 - d. Speedline Corporation.
 2. Adhesive shall have a VOC content of 80 g/L or less (if available) when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.04 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. VOC Content: 420 g/L or less.
 - 2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Knauf Insulation.
 - c. Vimasco Corporation.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, 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, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.

2.05 SEALANTS

- A. Joint Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - e. Pittsburgh Corning Corporation.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Permanently flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 100 to plus 300 deg. F.
 - 5. Color: White or gray.
 - 6. Sealant shall have a VOC content of 420 g/L or less.
 - 7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. FSK and Metal Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
 - 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. Sealant shall have a VOC content of 420 g/L or less.

7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 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. Sealant shall have a VOC content of 420 g/L or less.
 7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.06 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. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A.

2.07 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - b. Vimasco Corporation.

2.08 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
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.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 1. Sheet and roll stock ready for shop or field sizing.
 2. Finish and thickness are indicated in field-applied jacket schedules.
 3. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 4. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
 5. Factory-Fabricated Fitting Covers:
 - a. Same material, finish, and thickness as jacket.
 - b. Preformed 2-piece or gore, 45 and 90-degree, short and long-radius elbows.
 - c. Tee covers.
 - d. Flange and union cover.
 - e. End caps.
 - f. Beveled collars.
 - g. Valve covers.
 - a. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. 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 cross-laminated polyethylene film covered with white aluminum-foil facing.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Polyguard Products, Inc.
- F. 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/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Johns Manville; Saranex 540CX Vapor Retarder Film.
- G. 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/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Johns Manville; Saranex 540CX Vapor Retarder Film.
- H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:

- a. Johns Manville; Saranex 540CX Vapor Retarder Film or Saranex 560CX Vapor Retarder Film.

2.09 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Venture Tape.
 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Venture Tape.
 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Compac Corporation.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Venture Tape.
 - d. PVC Z-Tape, Z-Tape II, Johns Manville, a Berkshire-Hathaway Company
 2. Width: 2 inches.
 3. Thickness: 6 mils. (5-10 mil)
 4. Adhesion: 64 ounces' force/inch in width or (14-64 oz)
 5. Elongation: 150 -500 percent.
 6. Tensile Strength: 18 lbf/inch in width or (15-27 lbf/inch)
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Compac Corporation.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 - e. Venture Tape.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces' force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 2. Width: 3 inches.
 3. Film Thickness: 4 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.
 6. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. PVDC Tape for Indoor and outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive. (Since PVDC is not suitable for being left exposed outdoors, it is not the thickness that determines what thickness should be used but, rather, the desired permeance which is largely a factor of the pipe temperature. I recommend making this section applicable to both indoor and outdoor applications of PVDC Tape since the same tapes can be used in either application.)
See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. See Division 01 Section "Product Requirements."
Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
Johns Manville; Saranex 520CX Vapor Retarder Tape or Saranex 560CX Vapor Retarder Tape.
 2. Width: 3 inches.
 3. Film Thickness: 6 mils.
 4. Adhesive Thickness: 1.5 mils.
 5. Elongation at Break: 145 percent.
 6. Tensile Strength: 55 lbf/inch in width.

2.10 SECUREMENTS

- A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville
 - b. RPR Products, Inc.

- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel, or Monel.
- C. Wire: 0.062-inch soft-annealed, galvanized steel.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. C & F Wire.

PART 3 - EXECUTION

3.01 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.

3.02 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of 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 storage 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. Install outermost layer of insulation with longitudinal seams at the 3:00 and 9:00 positions of horizontal runs. (Longitudinal seams should be at the sides of horizontal pipe to avoid being stressed from pipe supports, being walked on, having things hung from the insulated pipe, etc. If there will be stresses applied to insulated pipe, it is most likely to be at the top or bottom of the pipe so you do not want to have the joints in the outermost layer at these locations). Check with manufacturer depending upon application.
- K. 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.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. 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. Jackets without a self-sealing lap are typically stapled or taped. Jackets like an ASJ jacket that have a self-sealing Lap adhesive system are not usually stapled for indoor applications. For below ambient air systems, any penetrations made in the vapor-retarder jacket needs to be sealed with appropriate vapor-retarder tape or mastic.
 4. Overlap jacket longitudinal seams at least 1 ½ 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 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 5. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. 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.
- Q. 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.

3.03 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.
 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.04 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. 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.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- 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 manufacturer's 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.

3.06 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Use the ASL-SSL pressure sensitive adhesive lap seal, and butt (circumferential) strips to seal the seams and joints respectively. Penetrations can be sealed with pressure-sensitive adhesive tape or vapor-retarder mastic. Follow manufacturer's instructions, which include sealing lap seal and butt strips having pressure-sensitive adhesive surfaces. When adhered, the lap and butt strips must be pressurized by rubbing firmly with a plastic squeegee or the back of a knife blade to ensure positive closure. For specific installations, secure each layer of Unfaced preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials. Check with manufacturer for instructions.
 2. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 3. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 4. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
 5. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, 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.

3.07 FIELD-APPLIED JACKET INSTALLATION

- A. 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 ½ -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.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. 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.
- C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. On horizontal pipe, overlap longitudinal seams arranged to shed water and locate longitudinal seams at 3:00 or 9:00 position on pipe. Seal end joints with weatherproof sealant recommended by insulation manufacturer. On vertical pipe, overlap end joint seams arranged to shed water and locate longitudinal joints to face away from prevailing wind. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints. Where PVDC jackets are indicated, install as follows: Apply wraps of filament tape at ends of each insulation section and on 12 inch centers to secure pipe insulation to pipe prior to installation of PVDC jacket.
- Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) 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.
- 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.
- Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) 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.

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.

D. 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-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized 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.

3.08 FINISHES

- A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
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.

3.09 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. 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.

- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 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.
 - 4. Geothermal heat pump supply and return piping.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric, 1 inch thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric, 1 inch thick.
- C. Condensate Piping: Mineral-fiber, preformed pipe insulation, 1 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping: Insulation shall be one of the following:
 - 1. Cellular Glass: 2 inches thick.
 - 2. Flexible Elastomeric: 2 inches thick.
 - 3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
 - 4. Polyolefin: 2 inches thick.
- B. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 2 inches thick.
 - 2. Polyolefin: 2 inches thick.

3.13 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, Concealed:
 - 1. None.
- D. Piping, Exposed:
 - 1. Aluminum, Smooth: 0.016 inch thick.

3.14 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. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed:

1. PVC: 20 mils thick.

END OF SECTION

SECTION 23 09 33 – BUILDING AUTOMATION SYSTEM – HONEYWELL N4 (NON-JAVA BASED)**PART 1 - GENERAL****1.01 OWNERS REQUIREMENTS**

- A. No additional software shall be required to operate, program, or troubleshoot equipment.
- B. All thermostats shall be 24 hr./7 day programmable type, auto changeover type. a +/- 3 degree adjustment by the occupant from the Building Automation System (BAS) setpoint. Thermostats shall not have occupancy override unless otherwise noted in the specifications. Provide locking covers (clear plastic, hinged type).
- C. Samples (snapshots) of the graphics shall be included in the Automatic Temperature Control (ATC) submittal.
- D. All building alarms must be sent to the local/main building alarm page accessed from the main site plan. Generic alarms are not acceptable and must indicate the reason the alarm has been generated. ATC Contractor to coordinate with owner and develop alarm categories (critical, non-critical, maintenance, etc.) and identify which category equipment, systems, components, etc. shall be placed. ATC Contractor to coordinate owner's notification requirements (local, remote, personnel, emails, texts, etc.). An alarm shall be sent to the main alarm page whenever a controller loses communication for more than 5 minutes.
- E. The ATC Contractor shall provide two (4 hour) training sessions for systems orientation, product maintenance, trouble shooting, and emergency contacts. ATC contractor to coordinate with owner/architect/engineer to determine representatives/designated staff to be present for the training. ATC Contractor to provide one training session during the heating (winter) season and one during the cooling (summer) season.
- F. The user shall have the ability to adjust scheduling blocks for each piece of equipment, floor, building, and the entire campus in addition to the individual zones. (i.e., occupied/unoccupied).
- G. An icon in the Navigation Bar shall display the pdf's of As-Built control diagrams and sequence of operations for all systems within the building/system being viewed. This shall open in a pop-up window.
- H. Furnish all labor, materials, equipment, and service necessary for a complete and operating control system to be integrated with the central building automation system, utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.
- I. Utilizing the BAS supervisor, the system shall be capable of remotely controlling, monitoring, accessing all equipment and systems controls described in this section and the drawings from multiple locations as determined by the client.
- J. Utilize network user function to be programmed into the Server. Passwords will need to be issued by the owner to the contractor prior to programming. No additional users shall be created by the vendor.
- K. Contractor to provide a hyperlink to the Main Site Map to open up each building floor plan showing areas under control (via the BAS).
- L. Provide emergency shut down for all fan forced systems on emergency shut down page on BAS.
- M. System shall be setup for auto backup of JACEs on a weekly basis via the AX Provisioning Service.
- N. Provide 1 year software maintenance agreement for each JACE provided. The contractor is

responsible for upgrading and installing any upgrades to the Niagara 4 Software during the warranty period.

O. Additional Graphics Requirements.

1. Building floor plan display should be color coded for each particular zone. (i.e., AHU zone: Area should be shaded differently than other zones.) Thermostat locations and thermostat number shall be identified.
2. Building floor plan to display current temperatures of those rooms.
3. Notification of a "blinking" red light shall be displayed when an area is in alarm.
4. If a controller is offline or lost power, a default value of last known value should not be displayed. It should be defined as "offline" and an alarm should be programmed into the system to notify that system is "offline." Unit temperature display shall become yellow.
5. From the building area floor plan graphic, there should be hyperlink created that allows one to proceed to HVAC equipment page for equipment serving that area.
6. Equipment should have an automated graphic display showing a status of equipment. This should be confirmed by both status and command values.
7. The dampers should be displayed in the position that they are physically in.
8. Set points should be displayed on the graphics.
9. Ability to override commands of valves, dampers, fans to be provided to allow system corrections and/or troubleshooting.
10. All programmed schedules to be accessible from the main floor plan page. Allow for click and change ability to modify schedules based on calendar year changes.
11. Pages shall have hyperlinks to navigate to main site home page, building home page, and adjacent floors within the building.
12. The graphics of a piece of equipment (i.e., fan, motor, etc.) in operation (energized, not energized, etc.) shall be displayed on the graphics to match the operations of the physical piece of equipment.
13. Provide hyperlinking between the equipment to the floor plan.

1.02 SUMMARY

A. Scope: Furnish all labor, materials, and equipment for a complete and operating Building Automation System (BAS) utilizing Direct Digital Controls as shown as drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section shall communicate on a peer-to-peer open protocol bus (s) such as LonTalk or BACnet.

1. The intent of the specification is to provide to the owner a BAS system(s) running the Niagara 4™ open NICS framework and be truly "open" at all levels. "Open" by definition includes "Sourcing" and "Product," and "Service" and "Expansion." Any contractor or integrator "certified" on Niagara 4 platform must be able to work on any device or network controller or supervisor without having to use other vendors or software to access parts of the network. This can best be described as an "open source," "open protocol," "open controller," "open supervisor" system with "open maintenance" and "system expansion."
2. BAS Systems that meet "Open definition":
 - a. **Manufacturers:** Honeywell Inc., Schneider Electric, or prior approved equal.
 - b. Control Contractor Requirement:
 - 1) Honeywell ACI or ACS – Certified Contractor.
 - 2) Minimum of (2) WEBS Niagara 4 certified employees.
 - 3) Minimum of (5) WEBS N4 installations with system supervisor interface.
 - c. Preapproved Honeywell ACI and ACS contractors for WEBS-N4™

“installation.”

3. Open NIC Statement

Niagara 4 includes a licensing model that provides OEMs with the ability to define the various levels and types of Niagara 4 interoperability their product will support. There are two primary interactions the NICs address – the sharing of data between stations (JACEs – WEBs-AX™ and Supervisors) and the ability for a tool (i.e., N4 workbench 4.3 or above) to engineer a station.

The NICS provides a structure (or schema) that OEMs can use to define the various levels and types of Niagara 4 interdependability their products will support. The NICs definitions are contained in the license file which is checked by a station or tool when it starts up.

Every licensed station and tool has a (Host ID). This field holds a text descriptor that the OEM chooses as the identifier its product line and each station can have only one Host ID entry.

Station Compatibility “In”

The field is a list of brands that this local station will allow Niagara 4™ data to come in from – “this is the list of brands that can accept data from.”

Station Compatibility “Out”

This Field is a list of brands that this local station will allow Niagara 4™ data to be shared with.

Total Compatibility “In”

This field is a list of brands that this station will allow to be connected to it for engineering of its applications.

Total Compatibility “Out”

This field is a list of brands that this tool is allowed to connect to and engineer.

For a BAS System(s) running Niagara 4™ from NICs framework and be truly “Open” at all levels ...

Example: No connectivity restrictions:

The station and tool “NICs” would be as follows:

Property	Value
Station Compatibility In	All
Station Compatibility Out	All
Total Compatibility In	All
Total Compatibility Out	All

4. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, and Modbus. Non LonTalk communication protocol for specific pieces of equipment must be approved on a case by case basis.
5. System architecture shall provide secure Web access using MS Internet Explorer from any computer on the owner’s LAN.
6. All control devices furnished with this Section shall be programmable directly from the Niagara-4™ Workbench upon completion of this project. The use of configurable

- or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.
7. Any control vendor that must provide additional BAS server software shall be unacceptable. Only systems that utilize the WEBS Niagara 4™ Framework shall satisfy the requirements of this section.
 8. The BAS server shall host all graphic files for the control system. All graphics and navigation schemes for this project shall match those that are on the existing campus Niagara 4 framework server.
 9. OPEN NIC STATEMENTS - All Niagara 4 software licenses shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*" and "accept.wb.in=*" and "accept.wb.out=*". All open NIC statements shall follow Niagara 4 Open NIC specifications
 10. All JACE hardware products used on this project must be Made in the USA or come through the Tridium Richmond, VA shipping facility. JACE hardware products not meeting these requirements will not be allowed.
- B. Furnish all labor, materials, equipment, and service necessary for a complete and operating control system to be integrated with the central BAS System, utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.
- C. All control wiring regardless if it is line or low voltage and it performs as control wiring, shall be the ATC Contractor's electrical subcontractor responsibility. ATC Contractor to allow for electrical contractor compensation for any line voltage work. Power for operation of valves, dampers, thermostats, and miscellaneous devices is control wiring.
- D. Drawings of the BAS network and associated systems are diagrammatic only and any apparatus not shown but required to make the system operative to the complete satisfaction of the owner/engineer shall be furnished and installed without additional cost.
- E. All wiring to be plenum rated in concealed areas and in conduit where exposed or subject to damage. All exterior exposed control wiring to be in conduit and weather protected. Conduit to be galvanized steel. No PVC piping is permitted in plenum.
- F. This contractor shall conform to the General and Supplementary Conditions Provisions under Division 1 of the Specifications. (Where applicable)
- G. This contractor shall conform to the Specifications Section 23 05 00: Mechanical General Provisions.
- H. Exposed control wiring in interior finished spaces;
1. Control wiring to run in Wiremold V500 series. (steel raceway, ¾") and associated fittings.
 2. Finish to be selected by architect.
 3. Contractor to coordinate all final Wiremold run locations and layout with architect/engineer for approval prior to ordering and rough-in.
- I. ATC Contractor to be present at equipment/system start-up and verify that all wiring and components are installed correctly and the equipment/system sequence of operation is operating as designed. ATC Contractor to perform final calibrations of all devices and equipment. ATC Contractor to make all the required corrections if the equipment/system does not operate correctly.
- J. ATC Contractor to coordinate with the test, balancing, and adjusting (TBA) contractor prior to performing equipment/systems tests that all air systems have been tested and balanced.
- K. The use or installation of all wireless equipment must be pre-approved by the owner and engineer.
- L. Tridium has developed a document that addresses many of the issues that IT managers have relating to Tridium's Niagara 4 Framework™ and platform and station connections. See www.tridium.com for document.
- M. All control panels to be NEMA 3R.

1.03 SYSTEM DESCRIPTIONS

- A. The entire BAS shall be comprised of interoperable, stand-alone digital controllers communicating via LonMark™/LonTalk™ and/or ™ communication protocols to a Network Area Controller (NAC). Temperature Control System products shall be by approved manufacturer that meet and fully comply with the intent of Sections 1.1, A.1.
- B. The BAS shall consist of controllers, sensors, thermostats, control valves, dampers, and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and perform functions specified.
- C. The BAS shall be comprised of Network Area Controller(s) (NAC) within the facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the systems, either locally in this building or remotely from a control site or sites, shall be accomplished through standard WEB browsers, supported MS Internet Explorer via Internet and/or local area network. Each NAC shall communicate to LonMark™/LonTalk™ (ILC) and/or ™ (IBC) controllers and other open protocol system/devices provided under Division 23, Division 26, etc.
- D. The BAS as provided in this Division shall be based on a hierarchical architecture incorporating the Niagara N4 Framework™. All control devices furnished shall be programmable directly from Tridium N4™ Workbench, WEBs Station N4™ or WEB Pro N4™ upon completion of this project. WEBs-N4™ "open" license embedded user interface "UI."

1.04 SPECIFICATION NOMENCLATURE - Acronyms used in this specification are as follows:

Actuator	Control device that opens or closes valve or damper in response to control signal.
AI	Analog Input
AO	Analog Output
Analog	Continuously variable state overstated range of values
BAS	Building Automation System
DDC	Direct Digital Control
Discrete	Binary or digital state
DI	Discrete Input
DO	Discrete Output
FC	Failed Closed position of control device or actuator. Devices move to closed position on loss of control signal or energy source.
FO	Fail open (position of control device or actuator). Device moves to open position on loss of control signal or energy source.
GUI	Graphical User Interface
HVAC	Heating, Ventilating and Air Conditioning
IDC	Interoperable Digital Controller
ILC	Interoperable Lon Controller
LAN	Local Area Network
Modulating	Movement of a control device through an entire range of values, proportional to an infinitively variable input value.
Motorized	Control device with actuator
NAC	Network Area Controller
NC	Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.

NO	Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
OSS	Operating System Server, host for system graphics, alarms, trends, etc.
Operator	Same as actuator
PC	Personal Computer
Peer-to-Peer	Mode of communication between controllers in which each device connected to network has equal status and each share its database values with all other devices connected to network.
P	Proportional control; control mode with continuous linear relationship between observed input signal and final controlled output element.
PI	Proportional-Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controller variable (reset control).
PICS	Product Interoperability Compliance Statement.
PID	Proportional-Integral-Derivative control, control mode with continuous correction of final controller output element versus input signal based on proportional error, its time history (reset) and rate at which it's changing (derivative).
Point	Analog or discrete instrument with addressable database value.
WAN	Wide Area Network
TCS	Temperature Control Systems
FMCS	Facility Management Control System
CD	Compact Disc
NICS	NIAGARA 4™ Compatibility Statement – see Part 1.1.3
IBC	Interoperable Controller
I/O Points	AI, AO, DI, DO
ACI	Honeywell designation acronym: Authorized Control Integrator.
ACS	Honeywell designation acronym: Automation Control Specialist
BCS	Honeywell designation acronym: (See ACS)
WBI	WEB Browser Interface
POT	Portable Operator's Terminal
PMI	Power Measurement Interface
OOT	Object Oriented Technology
ASD	Honeywell Designation: Authorized System Distributor
ISO-9001	Model for Quality Assurance in Design/Development, Production, Installation and Servicing.
PEC	Programmable Equipment Controllers
ASC	Application Specific Controllers
AUC	Advance Unitary Controllers
SNC	System Network Controller
SNMP	Simple Network Management Protocol
OEM	Original Equipment Manufacturer

OBDB
SQLOpen Database Connectivity
Structured Query Language

1.05 DIVISION OF WORK

- A. The ATC Contractor shall be responsible for all controllers (IDC and IBC), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.
- B. The ATC Contractor shall be responsible for the Network Area Controller(s) (NAC), software and programming of the NAC, Graphical User Interface software (GUI), development of all graphical screens, Web Browser pages, setup of schedules, logs and alarms, LonWorks network management and connection of the NAC to the local or Wide Area Network.

1.06 RELATED WORK SPECIFIED ELSEWHERE

- A. Reference General Conditions Section 23 05 00 for all portions of work that applies to BAS or BAS contractor.
- B. Division 26, Electrical:
 - 1. Providing starters and disconnect switches (unless otherwise noted).
 - 2. Power wiring and conduit (unless otherwise noted).
 - 3. Provision, installation and wiring of smoke detectors (unless otherwise noted).
 - 4. Other equipment and wiring as specified in Division 26.
- C. Division 23, Equipment Interface:

In the event the Division 23 equipment supplier has interface responsibility specified with the BAS, through communications with Lon™, ™ or ModBus, the ATC Contractor shall be responsible for the up-loading of I/O points and operational written perimeters, as detailed in Division 23; HVAC equipment and the here after sequence-of-operations to the NAC. It will be the responsibility of the Division 23 manufacturers/equipment supplier to coordinate the time and date with their factory trained control technician to facilitate/accomplish 100%, the I/O points and control perimeters with the ATC Contractor to fully meet the specification requirements. Upon completion and testing by both the BAS and the factory technician, all programming software will be given to the BAS for demonstration to the owner and will become property of the owner for use in the future.
- D. Refer to International Mechanical Code.
- E. Refer to National Electrical Code.

1.07 AGENCY AND CODE APPROVALS

- A. All products of the BAS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided on request, with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
 - 1. Federal Communications Commission (FCC), Rules and Regulations, Volume II – July 1986 Part 15 Class A Radio Frequency Devices
 - 2. FCC, Part 15, Subpart J, Class A Computing Devices.
 - 3. UL 504 – Industrial Control Equipment
 - 4. UL 506 – Specialty Transformers
 - 5. UL 910 – Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces
 - 6. UL 916 – Energy Management Systems All
 - 7. UL 1449 – Transient Voltage Suppression

8. Standard Test for Flame Propagation Height of Electrical and Optical – Fiber Cables Installed Vertically in Shafts.
 9. EIA/ANSI 232-E – Interface Between Data Technical Equipment and Data Circuit Terminal Equipment Employing Serial Binary Data Interchange.
 10. EIA 455 – Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
 11. IEEE C62.41 – Surge Voltages in Low-Voltage AC Power Circuits.
 12. IEEE 142- Recommended Practice for Grounding of Industrial and Commercial Power Systems
 13. NEMA 250 – Enclosures for Electrical Equipment (SIC)
 14. NEMA ICS 1 – Industrial Control Systems
 15. NEMA ST 1 – Specialty Transformers
 16. NCSBC Compliance, Energy Performance of Control System shall meet or surpass the requirements of ASHRAE/IESNA 90.1.
- B. All BACNET equipment/devices shall bear the “BTL” stamp.
- C. The BAS shall be BACNET-SC (secure connect) capable.
- 1.08 SOFTWARE OWNERSHIP
- A. The owner shall have full ownership and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BAS.
- 1.09 MECHANICAL GENERAL PROVISIONS
- A. ATC Contractor shall conform to the general and supplemental condition provisions under Division 23 05 00 and this specification.
- 1.10 DELIVERY STORAGE AND HANDLING AND SHIPPING TO OEM FACTORY.
- A. Provide factory shipping cartons for each piece of equipment and control device.
- B. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from the weather.
- C. Factory mounted Components: Where control devices are specified in this section or other specifications such as (equipment) to be factory mounted, the BAS shall arrange for shipping of control devices to equipment manufacturer. He will have responsibility of “tagging” control hardware prior to shipping if requested by equipment supplier. The BAS contractor will have the option of either down-loading program(s) prior to shipping or installing programs after mechanical equipment has been installed at site unless specific instructions are specified under 1.5C Equipment Interface.
- 1.11 QUALITY ASSURANCE
- A. Single source Responsibility of BAS.
1. The ATC Contractor shall be responsible for the complete installation and proper operations of the control system specified. The control system contractor shall exclusively be in regular and customary business of design, installation, and service of computerized building management systems similar in size and complexity to the system specified. Subcontracting the “Single Service Responsibility” tasks to others

covering any of the following: design and submission, graphics, software programming, field check, demonstrating operating compliance and warranty including using Automation System Distributor is not accepted.

2. The ATC Contractor shall have a full service DDC office. This office shall be staffed with applications' engineers, software engineers, and field technicians. This office shall maintain parts inventory and shall have all testing and diagnostic equipment to support their work, as well as staff trained in the use of this equipment.
3. The manufacturers of the BAS digital controllers shall, if necessary, provide documentation supporting compliance with ISO-9001.

1.12 RELATED WORK SPECIFIED ELSEWHERE

- A. Products Supplied But Not Installed Under This Section:
 1. Automatic control dampers, where not supplied with equipment.
 2. Airflow measuring stations.
 3. Terminal unit controllers and actuators, when installed by terminal unit manufacturer.
 4. Variable Frequency Drives. (This does not include VFDs integral to machinery such as chillers or boilers)
- B. Products Installed But Not Supplied Under This Section:
 1. None.
- C. Products Not Furnished or Installed But Integrated with the Work of This Section:
 1. Smoke Detectors (through alarm relay contacts).
- D. Work Required Under Division 26 Related to This Section:
 1. Power wiring to line side of motor starters, disconnects or variable frequency drives.
 2. Provision and wiring of smoke detectors and other devices relating to fire alarm system.
 3. Campus LAN (Ethernet) connection adjacent to JACE network management controller.

PART 2 - PRODUCTS

2.01 SYSTEM OVERVIEW

- A. The ATC Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP/IP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
- B. The BAS server software must support at least the following server platforms: Windows. The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
- C. The web browser Graphical User Interface (GUI) shall provide a completely interactive user interface and must offer and be configured with the following features as a minimum:
 1. Trending.
 2. Scheduling.
 3. Electrical demand limiting.
 4. Duty Cycling.
 5. Download Memory to field devices.
 6. Real time 'live' Graphic Programs.

7. Tree Navigation.
 8. Parameter changes of properties.
 9. Setpoint Adjustments.
 10. Alarm/Event Information.
 11. Configuration of operators.
 12. Execution of global commands.
 13. Add, delete, and modify graphics and displayed data.
- D. Software Components: All software shall be the most current version. All software components of the BAS system software shall be provided and installed as part of this project. BAS software components shall include:
- E. BAS Server Database: The BAS server software shall utilize a compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2, BAS systems written to Non-Standard and/or Proprietary databases are NOT acceptable.
- F. Database Open Connectivity: The BAS server database shall allow real time access of data via the following standard mechanisms:
1. Open protocol standard like SOAP
 2. OLE/OPC (for Microsoft Client's/Server platform only)
 3. Import/Export of the database from or to XML (Extensible Mark-up Language)
- G. The installed system shall provide secure password access to all features, functions and data contained in the overall BAS.
- H. Communication Protocol(s): The native protocol of the BAS server software shall be TCP/IP over Ethernet. Proprietary protocols over TCP/IP are NOT acceptable.
- I. Thin Client – Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
1. Web Browser's for PC's: Only the latest version of Microsoft/Firefox will be required as the GUI, and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.
 2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit-encryption technology within Secure Socket Layers (SSL). Communication Protocol shall be Hyper-Text Transfer Protocol (HTTP)

2.02 WEB BROWSER GRAPHICAL USER INTERFACE (GUI)

- A. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events.
- B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password. Navigation in the system shall be dependent on the operator's role privileges, and geographic area of responsibility.
- C. Navigation: Navigation through the GUI shall be accomplished by clicking on appropriate building on a campus site plan.
1. Upon navigating to the site, the page shall be broken into two areas, a Navigation Bar and General Area.

- D. Navigation Bar: The Navigation Bar shall provide General information of the site and basic navigation functions. It is to be located along the top of the page and shall display the following.
1. General information such as current time, outdoor temperature/humidity, building name, and page name.
 2. Navigation information that shall be provided is link back to site plan, to site histories, site specific alarm panel, building schedules, and the sites main home page.
 - a. Alarm Panel: This shall display the current number of unacknowledged alarms for the site and when selected, open the alarm panel in a popup window.
 - b. Histories: This shall display the histories for the current site being viewed and open in a popup window.
 - c. Sequence of Operation: This shall display the sequence of operations for all equipment within the site being viewed. This shall open in a pop-up window.
- E. General Area: The general area is the main display area for the site. It shall contain information such as floor plans and equipment details.
1. Floor Plans: The floor plan shall be created from Revit backgrounds and shall provide a general overview of the building floors that shows building room numbers and corresponding space temperatures and access to the equipment pages.
 2. Equipment pages: The views of equipment shall either be provided in a popup window or on the main general area depending on size of graphic need.
 - a. It shall display a general layout of the equipment and display all points created for the equipment. The user shall also have access to set points and be able to adjust with a simple click. Refer to section 2.04 for additional user adjustment requirements.
- F. Action Pane: The Action Pane shall provide several functional views for each HVAC or mechanical/electrical subsystem specified. A functional view shall be accessed by clicking on the corresponding button.
1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floorplans, equipment drawings, active graphic setpoint controls, web content, and other valid HTML elements. The data on each graphic page shall automatically refresh.
 2. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the property's pages shall require the operator to depress an 'accept/cancel' button.
 3. Schedules: Shall be used to create, modify/edit and view schedules based on the systems geographical hierarchy (using the navigation bar).
 4. Alarms: Shall be used to view alarm information geographically (using the navigation bar), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
 5. Trends: Shall be used to display associated trend and historical data, modify colors, date range, axis, and scaling.
 6. Logic – Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
 7. Other actions such as Print, Help, Command, and Logout shall be available via a dropdown window.
- G. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated, gifs or jpgs, vector scalable, active setpoint graphic controls shall be used to enhance usability. Graphic

tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:

1. Display Size: The GUI workstation software shall graphically display in 1024 by 768 pixels 24 bit True Color.
 2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
 3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors based on temperature. Difference from set point Red = temperature above set point; Blue = temperature below set point; additionally, Yellow = lost communication, Dark Red = alarm as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
 4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to indicate status of equipment.
 5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
 - a. Each piece of equipment monitored or controlled including each terminal unit.
 - b. Each building
 - c. Each floor and zone controlled.
- H. Hierarchical Schedules: Utilizing the Navigation Bar displayed in the web browser GUI, an operator (with password access) shall be able to define a Normal (occupied/ unoccupied), holiday or override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site, or floor area. For example, Independence Day 'Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Bar. No further operator intervention would be required and every control module in the system would be automatically downloaded with the 'Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Bar shall be shown in a summary schedule table and graph.
1. Schedules: Schedules shall comply with the LonWorks and standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
 - a. Types of schedule shall be Normal, Holiday or override
 - b. A specific date.
 - c. A range of dates.
 - d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
 - e. Wildcard (example, allow combinations like second Tuesday of every month).
 2. Schedule categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
 3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an 'individual tenant' group – who may occupy different areas within a building or buildings. Schedules applied to the 'tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the 'tenant group.'

4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler, and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
 5. Partial Day Exceptions: Scheduled events shall be able to accommodate a time range specified by the operator (i.e., board meeting from 6 pm to 9 pm overrides normal schedule for conference room).
 6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules, and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.
 7. The user shall have the ability to adjust scheduling blocks for the entire building in addition to individual zones.
- I. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Bar, shall be displayed in the Action Pane by selecting an 'Alarms' view. Alarms, and reporting actions shall have the following capabilities:
1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report, and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address, and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge, or force a return to normal in the Events View as specified in this section.
 2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
 3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
 4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Bar shall be used to setup Alarm Areas in the Graphic Pane.
 5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
 6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A 'network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
 7. Alarm Summary Counter: The view of Alarm in Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm); require acknowledgement, and total number of Alarms in the BAS Server database.
 8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.

9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Bar and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
 - a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
 - b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email services support pagers.
 - c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
 - d. Write Property: The write property reporting action updates a property value in a hardware module.
 - e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
 - f. Run External Program: The Run External Program reporting action launches specified program in response to an event.
- J. Trends: Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Bar and Graphic Pane.
 1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Bar and selecting a Trends button in the Graphic Pane. The system shall allow y- and x- axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
 2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server. Trend data, including run time hours and start time date and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
 3. Resolution: Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis. Provide 15 minute intervals for all trending points unless otherwise noted.
 4. Dynamic Update: Trends shall be able to dynamically update at operator-defined intervals.
 5. Zoom/Pan: It shall be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.
 6. Numeric Value Display: It shall be possible to pick any sample on a trend and have the numerical value displayed.
 7. Copy/Paste: The operator must have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e., CTRL+C, CTRL+V).
- K. Security Access: Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Password. Access to different areas of the BAS system

shall be defined in terms of Roles, Privileges and geographic area of responsibility as specified:

1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of 'easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
 - a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
 - b. Edit Privileges shall comprise: Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.
 - c. Function Privileges shall comprise: Alarm/Event Acknowledgment Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print, and Alarm/Event Maintenance.
2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible Navigation Bar. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

2.03 GRAPHICAL PROGRAMMING

- A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall a GPL is a method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices in conventional control systems, such as relays, switches, high signal selectors, etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.
- B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then form a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
- C. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
 1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
 2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
 3. Microblocks: Shall be software devices that are represented graphically and maybe connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
 4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
 5. Reference Labels: Labels shall be similar to wires I that they are used to form logical

connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e., two points labeled 'A' on a drawing are logically connected even though there is no wire between them.

6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
 7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields and shall contain 'push buttons for the purpose of selecting default parameter settings.
 8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
 9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
 10. Live Graphical Programs: The Graphic Programming software must support a 'live' mode, where all input/output data, calculated data, and set points shall be displayed in a 'live real-time mode.
- D. Additional Graphics Requirements
1. Building floor plan display should be color coded for each particular zone. (i.e., AHU Zone: Area should be shaded differently than other zones.). Thermostat locations and thermostat number shall be identified.
 2. Building floor plan to display current temperatures of those rooms.
 3. Notification of a "blinking" red light shall be displayed when an area is in alarm.
 4. If a controller is offline or lost power, a default value of last known value should not be displayed. It should be defined as "offline" and an alarm should be programmed into the system to notify that system is "offline." Unit temperature display shall become yellow.
 5. From the building area floor plan graphic, there should be hyperlink created that allows one to proceed to HVAC equipment page for equipment serving that area.
 6. Equipment should have an automated graphic display showing a status of equipment. This should be confirmed by both status and command values.
 7. The dampers should be displayed in the position that they are physically in.
 8. Set points should be displayed on the graphics.
 9. Ability to override commands of valves, dampers, fans to be provided to allow system corrections and/or troubleshooting.
 10. All programmed schedules to be accessible from the main floor plan page. Allow for click and change ability to modify schedules based on calendar year changes.
 11. Pages shall have hyperlinks to navigate to main site home page, building home page, and adjacent floors within the building.
 12. The graphics of a piece of equipment (i.e., fan, motor, etc.) in operation (energized, not energized, etc.) shall be displayed on the graphics to match the operations of the physical piece of equipment.
 13. Provide hyperlinking between the equipment to the floor plan.
- E. Contractor prior to programming the system graphics, shall obtain approved equipment templates from the owner to keep the graphics consistent.

2.04 BEST PRACTICES:

- A. Local building supervisor:
1. The local supervisor shall have its time synced with the NTP server.
 2. The passwords for the platform and administration shall be per the owner's standard.

3. Histories and alarm extensions will reside at this level and then sent up to server.

2.05 LONWORKS NETWORK MANAGEMENT

- A. Systems requiring the use of third party LonWorks network management tools shall not be accepted.
- B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
- C. The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.
- D. These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.
- E. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management databases at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

2.06 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing the LonWorks technology communication protocol and/or in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system.
- C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
- D. The supplied system must incorporate the ability to access all data using HTML/CSS enabled browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the existing Operating System Server currently located in the Facilities Office on the LAN. Systems requiring proprietary database and user interface programs shall not be acceptable.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.07 PORTABLE OPERATOR'S TOOL

- A. The laptop computer shall consist of an Intel Premium based laptop computer (minimum

processing speed of 2.0 GHz with 8GB RAM with minimum 64 bit O.S. and a 500-gigabyte minimum hard drive). It shall include a CD-ROM drive, and appropriate connectors and cables for communication with the Ethernet network. Operating system shall be Microsoft Windows 10 or latest version.

2.08 BAS SERVER HARDWARE (ADD ALTERNATE)

A. Computer Configuration (Hardware Independent)

1. Central Server. Owner shall provide a dedicated BAS server with configuration that includes the following components as a minimum:
2. 2 GHz, Intel Core I5 or higher, Core 2 Dual also acceptable P4 or higher CPU – Dual Processor.
3. 8 GB of RAM Minimum, 500 gigabyte minimum hard drive, solid state hard drive.
4. 40 gigabytes hard disk, 1.44M 3 1/2" floppy drive, SVGA Card with 1024 x 768, 24-bit True Color, Back-up system 24X CD Rom R/W Drive minimum, 24" Flat Screen Color Monitor, Keyboard, and mouse. Dual band wireless, Bluetooth.
5. Operating System for the server shall be Microsoft Windows 10 or latest version, 64 bit minimum.
6. Internet Explorer 11.0 or later
7. 10/10/1000 Mbps T Ethernet Port
8. Standard Client: The thin-client Web Browser, BAS GUI shall be Microsoft Internet Explorer (11.0 or later) running on 10 or latest version (with LX Compatibility Mode. No special software shall be required to be installed on the PCs used to access the BAS via a web browser.

2.09 BAS SERVER FUNCTIONS

- A. A central server shall be provided. The server shall support all Network Area Controllers (NAC) connected to the customer's network whether local or remote.
- B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection.
- C. It shall be possible to provide access to all Network Area Controllers via single connection to the server. In this configuration, each Network Area Controller can be accessed from a remote Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.
- D. The server shall provide the following functions, at a minimum:
 1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
 2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
 3. The server shall include a master clock service for its subsystems and provide time synchronization for all Network Area Controllers (NAC).
 4. The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
 5. The server shall provide scheduling for all Network Area Controllers and their underlying filed control devices.
 6. The server shall be capable of providing demand limiting that operates across all Network Area Controllers. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective

- demand control.
7. The server shall implement the Command Prioritization Scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.
 8. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
 9. The server shall provide central alarm management for all Network Area Controllers supported by the server. Alarm management shall include:
 - a. Routing of alarms to display, printer, email, and pagers.
 - b. View and acknowledge alarms.
 - c. Query alarm logs based on user-defined parameters.
 10. The server shall provide central management of log data for all Network Area Controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
 - a. Viewing and printing log data
 - b. Exporting log data to other software applications
 - c. Query log data based on user-defined parameters.

2.10 LIBRARY

- A. A Standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- B. The objects in this library shall be capable of being copied and pasted into the user's data base and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) Library, available to all registered users to provide new or updated objects and applications as they are developed.
- D. All control objects shall conform to the control objects specified in the specification.
- E. The library shall include applications or objects for the following functions, at a minimum:
- F. Scheduling Object. The schedule must conform to the schedule object as defined in the specification, providing 7 day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
- G. Calendar Object. The calendar must conform to the calendar object as defined in the specification, providing 12 month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point and click" selection. This object must be linkable" to any or all scheduling objects for effective event control.
- H. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals.
- I. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling, etc.) to maintain occupant comfort or for equipment freeze protection.
- J. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupancy time just far enough ahead to take advantage of the building's

- “flywheel” effect for energy saving. Provide automatic tuning of all start/stop time object properties based on the previous day’s performance.
- K. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the user’s screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.
1. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the specification.
 2. Analog Object – Minimum requirement is to comply with the standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 3. Analog Output Object – Minimum requirement is to comply with the standard for data sharing.
 4. Binary Input Object – Minimum requirement is to comply with the standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an “on” condition. The user must be able to specify either input condition as the “on” condition.
 5. Binary Output Object – Minimum requirement is to comply with the BAC net standard for data sharing. Properties to enable minimum on and off time for equipment protection as well as interstart delay must be provided. The Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the method of contention resolution shall not be acceptable.
 6. PID Control Loop Object – Minimum requirement is to comply with the standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral, and derivative control.
 7. Comparison Object – Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked outputs. Also, allow limits to be applied to the output value for alarm generation.
 8. Math Object – Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
 9. Custom Programming Objects – Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object

behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.

10. Interlock Object – Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after start-up to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
 11. Temperature Override Object – Provide an object whose purpose is to provide the capability of overriding a binary output to an “On” state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the temperature override level of start/stop command priority unless changed by the user.
 12. Composite Object – Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the “contained” application that are represented on the graphical shell of this container.
- L. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:
1. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide Lon Mark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.
 2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file and documentation for the device to facilitate device integration.
 3. For devices, provide the following objects at a minimum:
 - a. Analog In
 - b. Analog Out
 - c. Analog Value
 - d. Binary
 - e. Binary In
 - f. Binary Out
 - g. Binary Value
 - h. Multi9-State In
 - i. Multi-State Out
 - j. Multi-State Value
 - k. Schedule Export

- I. Calendar Export
 - m. Trend Export
 - n. Device
 - 4. For each object, provide the ability to assign the object a device and object instance number.
 - 5. For devices, provide the following support at a minimum.
 - a. Segmentation
 - b. Segmented Request
 - c. Segmented Response
 - d. Application Services
 - e. Read Property
 - f. Read Property Multiple
 - g. Write Property
 - h. Who-has
 - i. I-have
 - j. Who-is
 - k. I-am
 - l. Media Types
 - m. Ethernet
 - n. IP Annex J
 - o. MSTP
 - p. Broadcast Management Device (BBMD) function
 - q. Routing

Note: Depending on the project configuration and requirements, it may be desired to integrate data from devices that are not LonMark or. These could include industrial or plant floor devices such as PLC's. Because of the many drivers available, a common method of providing this integration is: Dynamic Data Exchange (DDE), MODBUS (DDEE), and Ole for Process Control (OPC).

2.11 NETWORK AREA CONTROLLER (NAC)/SYSTEM NETWORK CONTROLLER (SNC)

- A. These controllers are designed to manage communications between the programmable equipment controllers (PEC), application specific controllers (ASC), and advanced unitary controllers (AUC) which are connected to its communications trunks, manage communications between itself and other system network controllers (SNC) and with any operator workstations (OWS) that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.
- B. The controllers must be fully programmable to meet the unique requirements of the facility it must control.
- C. The controllers must be capable of peer-to-peer communications with other SNC's and with any OWS connected to the BAS, whether the OWS is directly connected, connected via modem or connected via the Internet.
- D. The communication protocols utilized for peer-to-peer communications between SNC's will be Niagara 4, TCP/IP and SNMP. Use of proprietary communication protocol for peer-to-peer communications between SNC's is not allowed.
- E. The SNC shall be capable of executing application control programs to provide:
 - 1. Calendar functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization.

6. Integration of LonWorks and ModBus controller data.
7. Network management functions for all SNC, PEC and ASC based devices.
- F. The SNC must provide the following hardware features as a minimum:
 1. One Ethernet Port-10/100 Mdps
 2. One RS-232/485 port
 3. One LonWorks Interface Port – 78KB FTT-10A
 4. Battery Backup
 5. Flash memory for long term data backup (if battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
- G. The SNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- H. The SNC shall provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
- I. The SNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
 1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
 - a. Alarm
 - b. Return to normal
 - c. To default
 2. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text
 - b. Email of complete alarm message to multiple recipients.
 - c. Pagers via paging services that initiate a page on receipt of email message.
 - d. Graphics with flashing alarm object(s).
 3. The following shall be recorded by the SNC for each alarm (at a minimum):
 - a. Time and date.
 - b. Equipment (air handler #, accessway, etc.)
 - c. Acknowledge time, date, and user who issued acknowledgement.
- J. Programming software and all controller “Setup Wizards” shall be embedded into the SNC.
- K. Operator Touch Screen Interface
Provide a color graphic display touch screen operator interface mounted on panel face as indicated on drawings. The Operator Touch Screen Interface shall serve as the user interface to the entire TCS and shall allow the monitoring and the control of all systems points without the use of a mouse or keyboard.
Access to the system shall be permission-based, configurable permission access levels based on operator’s role.
Information on the color graphic display shall be dynamic and automatically updated.

2.12 PROGRAMMABLE EQUIPMENT CONTROLLER (PEC)

- A. HVAC control shall be accomplished using LonMark™ based devices where the application has a LonMark™ profile defined. Where LonMark™ devices are not available for a particular application; devices based on LonMark™ shall be acceptable. For each LonWorks™ device that does not have LonMark™ certification, the device supplier must provide an XIF file for the device. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework™, that allow standard and customizable control solutions required in executing the “Sequence of Operation.”
- B. All PECs shall be application programmable and shall at all times maintain their LonMark™

- certification. All control sequences within or programmed into the ILC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
- C. The PECs shall communicate with the SNC at a baud rate of not less than 78.8K baud. The PEC shall provide LED indication of communication and controller performance to the technician, without cover removal.
 - D. The following integral and remote Inputs/Outputs shall be supported per each PEC:
 - 1. Four integral dry contact digital inputs.
 - 2. Six integral analog inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC).
 - 3. Three integral 4-20 ma analog outputs.
 - 4. Eight integral 24 Vac Triac digital outputs, configurable maintained or floating motor control outputs.
 - 5. One integral 20 Vdc, 65-mA power supply for auxiliary devices.
 - E. Each PEC shall have expansion ability to support additional I/O requirements through the use of remote Input/Output modules.

2.13 APPLICATION SPECIFIC CONTROLLERS (ASC'S)

- A. Application Specific Controllers (ASC's) shall be standalone EEPROM based configured to perform the sequences specified, and with I/O selected for the application. All unitary DDC controllers shall support the LonMark™ Functional Profile for the given application. ASCs shall be tested and listed under UL916 for computing devices. ASC enclosures shall be flame retardant compact plastic conforming to UL94-V5 for plenum mounting or plated steel. Each ASC shall be provided with face mounted LED type annunciation to continually display its operational mode: power, normal, or in an alarm state. As an alternative to the face mounted integral LED, the control contractor shall provide relay driven pilot lights mounted at the AC location, which shall provide the specified annunciation. ASCs shall be configured for DIN rail mounting using industry standard clip on adapters or direct panel mounted. The controller shall be programmable and configurable using Niagara 4 Framework™ and provide control solutions as required to executing the "Sequence of Operation."
 - 1. Input/Output Module
 - a. Provide a remote Input/Output module that connects sensors and actuators onto the field bus network for use by the NAC, ILC and ASC DDC Controllers. I/O Device shall support LonMark standard network communication technology for controller-to-controller communications. I/O Device shall have extended operating temperature rating from -40F to +150F so Device can be mounted directly in wiring cabinet of monitored appliances.

2.14 ADVANCED UNITARY CONTROLLER

- A. The advanced unitary controller (AUC) platform shall be designed specifically to control HVAC – ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes: water service heat pumps, air handlers, heat pumps, natural convection units. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework™, that allows standard and customizable control solutions required in executing the "Sequence of Operation."
- B. Minimum Requirements:
 - 1. The Controller shall be fully programmable with full functionality on any Niagara 4 brand platform.
 - a. Support downloads to the controller from any brand of Niagara 4 platform.
 - b. Support uploads from the controller to any brand of Niagara 4 platform.
 - c. Support simulation/debug mode of the controller.

- d. Maintain native GUI.
- e. Native function-block programming within the Niagara 4 environment.
- 2. The controller shall be capable of either integrating with other devices or standalone operation.
- 3. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications. Controller memory minimum requirements include:
 - a. FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
 - b. FLASH Memory settings retained for ten years.
 - c. RAM: 2 Kilobytes.
- 4. The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
- 5. The controller shall have an internal time with the ability to automatically revert from a master time clock on failure.
 - a. Operating Range: 24 hours, 365 days, multi-year-calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
 - b. Accuracy: +/- minute per month at 77° F (25° C).
 - c. Power Failure Backup: 24 hours at 32° to 122° F (0° to 50° C).
- 6. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
- 7. The controller shall have an internal DC power supply to power external sensors.
 - a. Power Output: 20 VDC +/- 10% at 75 Ma
- 8. The controller shall have visual indication (LED) of the status of the device:
 - a. Controller operating normally.
 - b. Controller in process of download.
 - c. Controller in manual mode under control of software tool.
 - d. Controller lost its configuration.
 - e. Now power to controller, low voltage, or controller damage.
 - f. Processor and/or controller are not operating.
- 9. The minimum controller Environmental ratings:
 - a. Operating Temperature Ambient Rating: -40° to 150° F (-40 to 65.5° C).
 - b. Storage Temperature Ambient Rating: -40° to 150° F (-40 to 65.5° C).
 - c. Relative Humidity: 5% to 95% non-condensing.
- 10. The controller shall have the additional approval requirements, listings, and approvals:
 - a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
 - b. CSA (LR95329-3) Listed.
 - c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
 - d. Meets Canadian standard C108.8 (radiated emissions).
 - e. Conforms requirements European Consortium standard EN 61000-6-1; 2001 (EU Immunity)
 - f. Conforms requirements European Consortium standard EN 61000-6-3; 2001 (EU Emission)
- 11. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35 mm).
- 12. The controller housing shall have a mix of digital inputs (DI), digital Triac Outputs

- (DO), analog outputs and universal inputs (UI).
- a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
 - b. Input and Output wiring terminals shall be removable from the controller without disconnecting the wiring.
 - c. Input and Output wiring terminals shall be designated with color coded labels.
 - d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20mA).
13. The controller shall provide for "user defined" Network Variables (NV) for customized configurations and naming using Niagara 4 Framework™.
14. The controller shall provide "continuous" automated loop tuning with Adaptive Integral Algorithm Control Loop.
15. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outline in Section four.
- a. Discharge air control and low limit.
 - b. Pressure-dependent dual duct without flow mixing.
 - c. Variable air volume with return flow tracking.
 - d. Economizer with differential enthalpy.
 - e. Minimum airflow coordinated with CO2.
 - f. Unit ventilator cycle (1, 2, 3) 2-pipe.
 - g. Unit ventilator cycle (1, 2, 3) 2-pipe with face/bypass
 - h. Unit ventilator cycle (1, 2, 3) 4-pipe.
 - i. Unit ventilator cycle (1, 2, 3) 4-pipe with EOC valve.

2.15 OTHER CONTROL SYSTEM HARDWARE

- A. Motorized control dampers that are not be integral to the equipment shall be furnished and installed by the Mechanical Contractor/ATC Contractor. Control damper frames shall be constructed of galvanized, steel, formed into changes and welded or riveted. Dampers shall be galvanized, with nylon bearings. Blade edge seals shall be vinyl. Blade edge and tip seals shall be included for all dampers. Blades shall be 16-guage minimum and 6 inches wide maximum and frame shall be of welded channel iron. Bearings shall be composed of a Celcon inner bearing with aluminum hexagon blade pivot pin, rotating within a poly carbonate outer bearing inserted in the frame. The dampers shall be equal to Tamco series 9000 ECT for parallel blade dampers and for opposed blade dampers. Dampers shall have a closed leakage rate of not more than 1.4 CFM per sq. ft. for 3'x3' damper at 1" S.P leakage class 1A.
- B. Control damper actuators shall be furnished by the ATC Contractor. Two-position or proportional electric actuators shall be direct-mount type sized to provide a minimum of 5 in-lb torque per square foot of damper area. Damper actuators shall be spring return type. Operators shall be heavy-duty electronic type for positioning automatic dampers in response to control signal. Motor shall be of sufficient size to operate damper positively and smoothly to obtain correct sequence as indicated. All applications requiring proportional operation shall utilize truly proportional electric actuators. All damper actuators (motors) installed in conjunction with an Air Handler/HVAC unit must be of the spring return, 2 position, occupied/unoccupied type, or modulating where an economizer cycle is required. Combustion air damper actuators shall be of the 2 position, spring return type.
- C. Wall Mount Room Temperature sensors: Each room temperature sensor shall provide temperature indication to the digital controller, provide the capability for a software-limited

occupant set point adjustment (warmer-cooler slider bar or switch) and limited operation override capability. Room temperature Sensors shall be 20,000-ohm thermistor type with a temperature range of -40 to 140 degrees F. The sensor shall be complete with a decorative cover and suitable for mounting over a standard electrical utility box. These devices shall have an accuracy of 0.5 degrees, F., over the entire range.

- D. Digital Wall Module Option
1. The Digital Wall Sensor shall have the ability to:
 - a. Control user access to control parameters
 - b. Customize parameter access by using the Niagara 4 Workbench tool.
 - c. Be programmable for: Home screen options, tenant access, contractor access, access to controller parameters, setpoint, override, fan, and other parameters.
 - d. Balance the VAV system from the wall module.
 - e. Configurable Home screen options
 - f. Network bus jack
 - g. Retain user configuration, including set points after a power outage.
- E. Duct-mounted and Outside Air Temperature Sensors: 20,000-ohm thermistor temperature sensors with an accuracy of $\pm 0.2^{\circ}\text{C}$. Outside air sensors shall include an integral sun shield. Duct-mounted sensors shall have an insertion measuring probe of a length appropriate for the duct size, with a temperature range of -40 to 160 degrees F. The sensor shall include a utility box and a gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 8 – foot long sensor element. These devices shall have accuracy of 0.5 degrees F, over the entire range.
- F. Humidity sensors shall be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 – 30 VDC input voltage, analog output (0-10 VDC or – 20 mA output). Operating range shall be 0 to 100% RH and 32 59 140-degree F. Sensors shall be selected for wall, duct, or outdoor type installation as appropriate.
- G. Carbon Dioxide Sensors (CO₂): Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus five percent (5%) or 75 PPM, whichever is greater. Response shall be less than one minute. Input voltage shall be 20 to 30 VAC or DC. Output shall be 0 – 10 VDC. Sensor shall be wall or duct mounted type, as appropriate for the application, housed in a high impact plastic enclosure.
- H. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.
- I. Differential Analog (duct) Static Pressure Transmitters provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy shall be plus or minus 1% of full range; range shall be selected for the specific application. Provide zero and span adjustment capability. Device shall have integral static pickup tube.
- J. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches shall have adjustable set points and barbed pressure tips. +/- 5% accuracy, - 1" to + 1 "P.G.
- K. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, size for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch shall be UL listed.
- L. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control panel shall be factory wired. Control panel shall be assembled by the BAS in a UL-Certified 508A

- panel shop. A complete set of 'as-built' control drawings (relating to the controls within the panel) shall be furnished within each control panel.
- M. Pipe and Duct Temperature sensing elements: 20,000-ohm thermistor temperature sensors with an accuracy of $\pm 1\%$ accuracy. Their range shall be -5 to 250°F. Limited range sensors shall be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel shall be included.
 - N. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F., range, and vapor-charged temperature sensor. Honeywell model L482A, or approved equivalent.
 - O. Relays: Start/stop relay model shall provide either momentary or maintained switching action as appropriate for the motor being started. All relays shall be plugged in, interchangeable, mounted on a subbase and wired to numbered terminals strips. Relays installed in panels shall all be DPDT with indicating lamp. Relays installed outside of controlled devices shall be enclosed in a NEMA enclosure suitable for the location. Relays shall be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.
 - P. Emergency Stop Switches: Provide toggle-type switch with normally-closed contact. Switch shall be labeled "AIR HANDLER EMERGENCY SHUTOFF, NORMAL – OFF."
 - Q. Transducers: Differential pressure transducers shall be electronic with a 4-20 mA output signal compatible to the Direct Digital Controller. Wetted parts shall be stainless steel. Unit shall be designed to operate in the pressure ranges involved.
 - R. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers shall be sized for the load, but shall be sized for 50 watts, minimum. Transformers shall be UL Listed Class 2 type, for 120VAC/24VAC operation.
 - S. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits shall be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall meet UL, ULC 149, IEEE C62.41B A grounding conductor, (minimum 12 AWG), shall be brought to each control panel.

2.16 CONTROL DEVICES

- A. All electrical wiring for the control system shall be as specified in this section and the Electrical Section of the Specifications and as required by local codes. The wiring shall be by this contractor.
- B. Electric thermostats shall be low-voltage, modulating type to control modulating devices, or low- or line-voltage type with heat anticipator for two-position controls. Provide locking covers (clear plastic, hinged type).

2.17 DUCT SMOKE DETECTORS

- A. Duct smoke detectors shall be of the photo-electronic type with sampling tube of ample length to traverse the entire width of the duct. Duct smoke detectors shall be manufactured by the control companies, the fire alarm companies, B.R.K. Electronics or approved equal. All HVAC units of 2000 CFM or more shall have duct smoke detectors in both the supply and return air streams. A single duct smoke detection in the return air stream shall be provided only when acceptable to the local authority having jurisdiction.
- B. Duct smoke detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
- C. Units of 15,000 CFM or more shall have two detectors. (supply and return air)
- D. Furnish and install where indicated on the drawings or required elsewhere in the specifications air duct smoke detectors. They shall integrate photoelectric, ionization and

heat sensing technologies for optimum detection accuracy and to prevent unwanted alarms. Auxiliary contacts shall be provided to shut down the air handling unit fan. The detector shall output to a remote alarm indicator.

- E. Duct smoke detectors to be furnished by the electrical contractor.
- F. Duct smoke detectors shall be installed by the mechanical contractor.
- G. Interconnection between the duct smoke detectors and fire alarm system shall be performed by the electrical contractor/fire alarm contractor.
- H. Control's integration to shut down the HVAC equipment in alarm shall be performed by the mechanical contractor/ATC contractor.

PART 3 - EXECUTION

3.01 SUBMITTALS

- A. The materials, equipment and software design shall be submitted as follows:
 - 1. Control Contractor shall submit qualifications as outlined in Part 1, 1.1.A.2.b Control contractor requirement including:
 - a. Names of Tridium/WEBS N4 certified employees in your employ today.
 - b. List (5) WEBS-N4™/ WEBS-N4™ Supervisor projects of similar size.
 - c. Location of principal place of business that would respond to service requests the first year.
 - d. Letter from Honeywell Regional representative stating your company is in good standing with the ACI and ACS Program.
 - e. Requirements (a thru d above) shall be submitted to project engineer for review for approval. No work shall be allowed without written approval. All information shall be handled in confidence and not for distribution to third parties.
 - f. Requirements of Quality Assurance (1.10) shall apply fully also and acknowledge in written form.
 - 2. Submittals to include but not limited to:
 - a. Submit shop drawings of all components.
 - b. Submit manufacturers' data sheets of valve Cv performance.
 - c. Submit design data and sequence of operations descriptions for all systems.
 - d. Submit wiring diagrams of electrical or electronic control systems.
 - e. ATC Contractor to include all input and output points for engineer review and approval.
 - f. At the completion of the project, submit final "as-built" drawings/CAD disk, all associated component/equipment cut-sheets/submittals, wiring diagrams, and final/actual sequence of operations descriptions of each system. Include ATC emergency contact information.
 - 3. Four copies of shop drawings or the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers' catalog data sheets and installation instructions, samples of written controller checkout sheets and performance verification procedures for applications similar in scope shall be included for approval.
 - 4. Shop drawings shall also contain complete wiring I/O point list for each system, schematic diagrams, sequences of operations, control system bus layout and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Shop drawings shall be approved before any

equipment is installed. Please allow 7 days for submission, review and return by engineer.

- a. All dampers and actuator valves and actuator shall be sized and submitted with shop drawing. Schedule shall include:
 - b. Identification tags all dampers/valves.
 - c. Location all damper/valves.
 - d. Damper and/or Valve type.
 - e. Actuator size and type.
 - f. Damper and/or valve pressure drop.
5. Submittal shall also a "sample of prior art" for project of the graphics. This web-based interface with the network via dynamic color shall include a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation.
6. Minimum depiction for graphics for project:
- a. Building picture and site plot plan (aerial or ground view provided by owner).
 - b. Building floor plan.
 - c. Each mechanical system.
 - d. Control devices depicted by point-and-click graphics.

Note:

Floor plan shall indicate each mechanical zone with different colors shaded as required to depict which zones are not maintaining temperature/humidity/pressure/CO₂, etc programmable levels/limits and which zones are in alarm.

Provide animated graphic for each system component including rooftop units, air handling units, UAV terminals, fan powered terminals, exhaust fans, supply fans, hot water systems – boilers, hot water pumps; chilled water systems – chillers, cold water pump condenser water pumps, cooling towers, etc.

The graphics are intended to be 20% - 30% complete at this stage with changes to be based on review comments from the engineer and/or owner.

- B. Upon completion of the work, provide a complete set of as-built drawings on compact disk (CD). Additionally, all control device furnished with this section shall be programmable directly from Tridium N4™ workbench.
- C. Upon completion of this project, the following copies of software shall be included on CD for the owner:
 1. The ATC Contractor shall use the "contract CD to owner – software package" to simulate all software application programs to ensure such programs are free from design errors and they accurately accomplish the application(s) sequence-of-operation. This simulation shall include the WEBS-N4™ embedded tool in controller allowing for the capability of other Niagara 4 factory certified contractor(s) access to the programming capability. The simulation shall be demonstrated before the owner/engineer at time and place arranged by the owner. Allow for a minimum of (8) hours for the demonstration and software changes resulting from the demonstration the owner feels should be changed/enhanced, etc. will/may result in another demonstration if so requested by owner. These changes will be made at no additional expense to owner.
 2. Four copies of the "as-built" drawings shall be provided in addition to the document

on compact disk. All "as-built" drawings shall also be installed into the BAS server in a dedicated directory. For each JACE™ (WEBs-N4™) the station shall be copied to supervisor and distribution file copy back-up and written to CD to owners' hands.

3. Control contractor shall provide "quote" to owner to install mechanical equipment service information such as, spare parts list, mechanical service contractors, etc into FMCS server as a dedicated directory. Owner, working with engineer, shall develop specification requirements for control contractor. ATC Contractor shall include (8) hours of technical support, including updating information as requested by owner, covering the time interval of the warranty period.

3.02 INSTALLATION

- A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
- B. Line and low voltage electrical connections to control equipment show specified or show on the control diagrams shall be furnished and installed by the ATC Contractor in accordance with these specifications.
- C. Equipment furnished by the Mechanical Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the ATC Contractor (ATC Contractor to coordinate with the Mechanical Contractor).
- D. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic label.
- E. Installation of Network
 1. Ethernet
 - a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.
 - b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 10 Base 2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors, 10 Base T (Twisted-Pair-RJ-45 terminated UTP cabling).
 2. LonWorks
 - a. The network shall employ LonTalk communications FTT-10.
 3. MS/TP
 - a. The network shall employ MS/TP EIA-485-A Standard.
 - b. The MS/TP EIA-485 network shall use shielded, twisted-pair cable with a characteristic impedance between 100 and 130 ohms.
- F. Installation of Digital Controllers and Programming
 1. Provide a separate digital control panel for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature could be located on any of the remote control units.
 2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
 3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.
 4. Provide software programming for the applications intended for the systems specified and adhere to the strategy algorithms provided.

5. Provide graphics for each piece of equipment and floor plan in the building. This includes each chiller, cooling tower, air handling unit, fan, terminal unit, boiler, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.

3.03 WIRING

- A. All wiring to be plenum rated in concealed areas and in conduit where exposed or subject to damage. All exterior exposed control wiring to be in conduit and weather protected. Conduit to be galvanized steel. No PVC piping is permitted in plenum.
- B. All control wiring and power wiring to the control panels, NAC, computers, and network components shall be the responsibility of this contractor.
- C. All wiring shall be in accordance with the National Electrical Code and any applicable local codes. All wiring shall be installed in the conduit types specified unless otherwise allowed by the National Electrical Code or applicable local codes.

3.04 START UP

- A. The ATC Contractor shall verify that all wiring is properly connected and free of all shorts and ground faults. Verify that all connections are tightened appropriately. Calibrate each device as required by the manufacturer's recommendations.
- B. Verify that the digital output devices operate properly and that the normal positions are correct.
- C. Verify that all analog output devices are functional, that start point and span are correct, and that direction and normal positions are correct including fail-safe positions. The ATC Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The ATC Contractor shall make any necessary adjustment to valve stem and damper blade travel.
- D. Complete software shall be installed and tested (dry run) prior to start-up.
- E. Software technician shall observe and fine tune all control loops.
- F. Alarms and interlocks:
 1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 2. Interlocks shall be tripped using field contracts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
- G. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
- H. Return the system to a normal operating state after each phase of start-up, commissioning, and demonstration. Any points overridden, devices place in manual position, setpoint adjusted, etc. are to be restored to normal operation condition prior to acceptance.
- I. Connection to the Internet must be tested and communication confirmed.

3.05 SYSTEM VALIDATION AND DEMONSTRATION

- A. As part of final system acceptance, a system demonstration is required (see below). Prior to start of this demonstration, the ATC Contractor is to perform a complete validation of all aspects of the Controls and Instrumentation System.
- B. Validation
 1. Prepare and submit for approval a Validation Test Plan including Test Procedures for the performance verification tests. Test Plan shall address all specified functions of the Engineering Control Center and all specified sequences of operation. Explain in

detail actions and expected results used to demonstrate compliance with the requirements of this specification. Explain the method for simulating the necessary conditions of operation used to demonstrate performance of the system. Test plan shall include a Test Check List to be used by the Installer's agent to check and initial that each test has been successfully completed. Deliver Test Plan documentation for the performance verification tests to the Architect or Owner's Representative, 30 calendar days prior to start of performance verification tests. Provide draft copy of operation and maintenance manual with performance verification test.

2. After approval of the Validation Test Plan, Installer shall carry out all tests and procedures therein. Installer shall completely check out, calibrate, and test all connected hardware and software to insure that system performs in accordance with approved specifications and sequences of operation submitted. Installer shall complete and submit Test Check List.

C. Demonstration

1. System operation and calibration to be demonstrated by the ATC Contractor in the presence of the Engineer, Architect or Owner's representative on random samples of equipment as dictated by the Owner's representative. Should random sampling indicate improper commissioning, the owner reserves the right to subsequently witness complete calibration of the system at no additional cost to the owner.
2. Demonstrate to authorities that all required safeties and life safety functions are fully functional and complete.
3. Make accessible personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.
4. Witnessed validation demonstration of Operator's Terminal functions shall consist of:
 - a. Running each specified report.
 - b. Display and demonstrate each data entry to show site specific customizing capability. Demonstrate parameter changes.
 - c. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
 - d. Execute digital and analog commands in graphic mode.
 - e. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs 6 loops minimum.
 - f. Demonstrate BAS performance via trend logs and command trace.
 - g. Demonstrate scan, update, and alarm responsiveness.
 - h. Demonstrate spreadsheet/curve plot software, and its integration with database.
 - i. Demonstrate on-line user guide, and help function and mail facility.
 - j. Demonstrate digital system configuration graphics with interactive upline and downline load, and demonstrate specified diagnostics.
 - k. Demonstrate multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
 - l. Demonstrate class programming with point options of beep duration, beep rate, alarm archiving, and color banding.

3.06 PROJECT CLOSEOUT - ACCEPTANCE TESTING

- A. Upon completion of the installation, the ATC Contractor shall load all system software and start-up system. The ATC Contractor shall perform all necessary calibration, testing and debugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.
- B. System Acceptance: Satisfactory completion is when the ATC Contractor has performed

successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.07 OPERATOR TRAINING

- A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the ATC Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software, and accessories.
- B. The BAS Contractor shall provide 8 hours of comprehensive training in three separate sessions (24 hours total) for system orientation, product maintenance and troubleshooting, programming, and engineering, if not provided under a previous contract at the site using the same brand and type of controllers within the previous 3 years.
- C. Train the designated staff or representative to enable them to do the following:
 - 1. Day-to-Day Operations:
 - a. Proficiently operate the system.
 - b. Understand control system architecture and configuration.
 - c. Understand BAS system components.
 - d. Understand system operation, including BAS system control and optimizing routines (algorithms).
 - e. Operate the workstation and peripherals.
 - f. Log on and off the system.
 - g. Access graphics, point reports, and logs.
 - h. Adjust and change system set points, time schedule, and holiday schedules.
 - i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
 - j. Understand system drawings and Operation and Maintenance Manuals.
 - k. Understand job layout and location of control components.
 - l. Access data from BAS controllers and application specific controllers.
 - m. Operate portable operator terminals.
 - 2. Advanced Operators:
 - a. Make and change graphics on the workstation.
 - b. Create, delete, and modify alarms, including annunciation and routing of these.
 - c. Create, delete, and modify point trend logs and graphic or print these both on an ad-hoc basis and at user-definable intervals.
 - d. Create, delete, and modify reports.
 - e. Perform BAS system field checkout procedures.
 - f. Perform BAS controller unit operation and maintenance procedures.
 - g. Perform workstation and peripheral operation and maintenance procedures.
 - h. Perform BAS diagnostic procedures.
 - i. Configure hardware including PC boards, switches, communication, and I/O points.
 - j. Adjust, calibrate, and replace system components.
 - 3. System Managers/Administrators
 - a. Interface with job-specific, third party operator software.
 - b. Add new users and understand password procedures.
- D. Sessions shall be scheduled so that at least one training session shall occur during heating

season and one during cooling season.

3.08 WARRANTY PERIOD SERVICES

- A. Equipment, materials, and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance by owner.
- B. Within this period, upon notice by the Owner, any defects in the BAS due to faulty materials, methods of installation or workmanship shall be promptly repaired or replaced by the ATC Contractor at no expense to the Owner.
- C. Maintenance of Computer Software Programs: The ATC Contractor shall maintain all software during the warranty period. In addition, all factory or sub-vendor upgrades to software shall be added to the systems, when they become available, at no additional cost. New products are not considered upgrades in this context.
- D. Maintenance of Control Hardware: The ATC Contractor shall inspect, repair, replace, adjust and calibrate, as required, the controllers, control devices and associated peripheral units during the warranty period. The ATC Contractor shall then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work and description of the corrective actions taken. The report shall clearly certify that all software and equipment/systems are functioning correctly.
- E. Service Period: Calls for service by the Owner shall be honored within 24 hours and are not to be considered as part of routine maintenance.
- F. Service Documentation: A copy of the service report associated with each owner-initiated service call shall be provided to the owner.

3.09 WARRANTY ACCESS: Verify with owner(s) and/or IT representative on the model of service access into your BAS system for the warranty period. This access shall cover diagnostics and troubleshooting.

- A. The Owner shall grant to the ATC Contractor reasonable access to the BAS during the warranty period. Remote access to the BAS (for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) will be allowed.

3.10 OPERATION & MAINTENANCE MANUALS

- A. See Part 1 and Part 3 for requirements. O&M manuals shall include the following elements, as a minimum.
 - 1. As-built control drawings for all equipment.
 - 2. As-built Network Communication Diagram.
 - 3. General description and specifications for all components.
 - 4. Completed Performance Verification Sheets.
 - 5. Completed Controller Checkout/Calibration sheets.
 - 6. (1) Copy of "Owner's CD" as specified in Section 23 00 00.
 - 7. All equipment manufacturers/suppliers shall provide in writing (and documented if requested by the Owner) a NICS statement indication the interface with their equipment has no connectivity restrictions.
 - 8. Niagara 4 JACE start up form must be submitted for each JACE provided. This is to include:
 - a. TCP/IP Settings
 - b. Platform Credentials
 - c. Administration level station access credentials
 - d. Installed version number.

- e. Licensed version number.
- f. Model, serial, and Host ID.

The station and tool "NICS" would be as follows:

Property	Value
Station Compatibility In	All
Station Compatibility Out	All
Total Compatibility In	All
Total Compatibility Out	All

PART 4 - SEQUENCE OF OPERATIONS

4.01 GENERAL NOTES

- B. The mechanical contractor shall retain a qualified ATC sub-contractor to furnish all labor, materials, equipment, and service necessary for a complete and operating ATC system, utilizing direct digital controls (DDC) as shown on the drawings and described herein. The BAS shall provide standalone access using a standard web browser, HVAC system control, energy management, alarming, monitoring, trending and reporting functions with operator interface. The BAS shall include a web-based operator interface depict each mechanical system and building floor plan by a point-and-click graphic. The web server shall reside on the building owner's network and shall be provided with an IP address by the owner. The web server shall gather data from the mechanical systems and generate web pages accessible through a conventional web browser on each pc connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
- C. The BAS system shall provide:
 - 1. Stand-alone independent control for all mechanical systems as described in the sections that follow.
 - 2. Alarm management capability for all mechanical equipment described in the sections that follow – including alarm occurrence, annunciation, remote dial-out to remote sites or pagers, acknowledgement, problem diagnostics, and reporting functions.
 - 3. Complete password protected system monitoring through a local networked operator workstation, or through remote operator workstations. Remote workstations shall utilize telephone or internet or ethernet communications links, as required.
 - 4. The mechanical contractor shall submit equipment submittals of all mechanical equipment to the ATC contractor for review prior to ordering the equipment.
 - 5. BAS web controllers and main control panel shall be connected to 120V emergency power provided by the electrical contractor.
 - 6. All ATC wiring, components and installation shall comply with the National Electrical Code.
 - 7. ATC contractor shall utilize low voltage conductors (solid or stranded) of the appropriate gauge and approved by the thermostat manufacturer.

8. All occupied, unoccupied and morning warm-up periods and all temperature set points for all spaces and systems, shall be defined by the BAS and be fully adjustable.

4.02 ROOFTOP VAV DX/GAS HEATING UNITS

A. General

1. Rooftop unit shall be provided with an open protocol BACNET controller.
2. ATC contractor shall provide, install and wire the duct mounted pressure sensors for VFD operation.
3. A duct mounted temperature sensor shall be shipped loose and field mounted in the supply ductwork to control the heating and cooling cycles of the unit.
4. The unit shall be provided with outside air temperature, outside air dew point, "proof of flow" air flow and dirty filter sensors.
5. Occupied/unoccupied shall be determined by the BAS time clock.

B. Operation

1. The supply fan shall operate continuously in occupied hours and cycle in unoccupied hours/evening hours. The supply fan shall operate continuously and the supply fan VFD shall vary the fan speed in response to a signal from the supply duct mounted pressure sensor.
2. Ventilation air - during occupied hours, the outside air damper shall be open. During the evening and unoccupied hours, the outside air damper shall be closed unless unoccupied cooling can be achieved via economizer.
3. Economizer - when the outside air temperature is lower than the space air temperature and the outside air dewpoint temperature is below 55°F, the unit shall operate in 100% outside air mode with no mechanical cooling.
4. Cooling - on a call for cooling, the mechanical cooling shall be staged via hot gas bypass to maintain a minimum 55°F (adj.) Leaving air temperature with the outside air damper in the minimum position to satisfy the space cooling requirements. The supply air temperature can be reset to 65°F max if all cooling loads are satisfied.
5. Heating - on a call for heating, the gas fired heat exchanger shall be staged to maintain 55°F (adj.) Leaving air temperature with the outside air damper in the minimum position to satisfy the space heating requirements. If all spaces are satisfied for cooling, the heating supply air temperature shall be reset to 65°F max.
6. "morning warm-up" mode
 - a. The supply fan shall operate continuously and the outside air damper shall be closed.
 - b. The BAS shall command all of the VAV boxes to fully open their inlet damper and the gas fired heat exchanger shall be staged to raise the building space temperature to 70°F (adj.).
 - c. The outdoor air temperature sensor shall anticipate the warm-up start time to achieve occupied temperatures at opening.

- C. (All single duct VAV box systems only) unoccupied heating - on a call for heating, the BAS shall command all of the VAV boxes to fully open their inlet damper and the gas fired heat exchanger shall be staged to maintain 65°F (adj.) In the building. The outside air damper shall be closed during unoccupied heating.

- D. Provide a duct smoke detector in each unit 2,000 CFM or over in the return air connection and in the supply air ductwork.

- E. Fire alarm shutdown – If the duct smoke detectors sense smoke, then any combination fire/smoke dampers shall close and the associated unit shall be de-energized. The unit shall not be permitted to operate until all trouble signals are cleared on the fire alarm system.
 - 1. Similarly, if any Fire and Smoke Damper associated with the RTU is closed, the unit shall be de-energized. The unit shall not be permitted to operate until all trouble signals are cleared on the fire alarm system.
- F. Carbon Dioxide Reset
 - 1. Sensor shall be installed in a protective cover (clear plastic with locking cover). Coordinate final location with engineer.
 - 2. When at least (2) CO2 sensors associated with a RTU system read carbon dioxide levels above the set point (700 PPM) the primary air damper shall gradually open from its minimum position to 15% above the minimum position.
 - 3. When all CO2 sensors associated with a RTU system read carbon dioxide levels below the set point, the primary air damper shall gradually close down to the minimum position.
- G. Integrate with the BAS.

4.03 SPLIT SYSTEM HEAT PUMPS WITH AUXILIARY HEAT

- A. General
 - 1. Air Handling Unit (AHU) shall be provided with a wall mounted heat programmable 24 hr./ 7-day thermostat with occupied/unoccupied scheduling and independent emergency heat operation.
 - 2. ATC contractor shall install and wire thermostat. Confirm final location with architect prior to rough-in.
 - 3. ATC contractor shall coordinate set points with owner.
 - 4. ATC contractor shall mount and wire condensate overflow switch.
 - 5. AHU shall be interlocked with remote duct mounted electric heating coil.
 - 6. Split system heat pump shall be provided with an open protocol BACNET controller.
 - 7. Occupied/Unoccupied shall be determined by the BAS time clock.
- B. Operation (occupied mode)
 - 1. Cooling - on a call for cooling, the unit shall operate to maintain 72°F (adj.).
 - 2. Heating - on a call for heating, the thermostat shall enable the unit's first stage of heat (heat pump) operate to maintain 70°F (adj.). If the first stage of heat is unable to achieve the space temperature setpoint, the unit shall disable compressorized heating and enable the second stage of heat (electric heat). Simultaneous compressorized heating and electric heating shall be prohibited. The thermostat shall allow for the occupant to manually select the emergency heat position.
 - 3. The condensate overflow switch mounted in the cooling coil drain pan shall deenergize the unit whenever enabled. Unit shall be manually restarted.
- C. Operation (unoccupied mode)
 - 1. Cooling - on a call for cooling, the unit shall operate to maintain 78°F (adj.).
 - 2. Heating - on a call for heating, the thermostat shall enable the unit's first stage of heat (heat pump) operate to maintain 65°F (adj.). If the first stage of heat is unable to achieve the space temperature setpoint, the unit shall disable compressorized heating and enable the second stage of heat (electric heat). Simultaneous compressorized heating and electric heating shall be prohibited. The thermostat shall allow for the occupant to manually select the emergency heat position.

3. The condensate overflow switch mounted in the cooling coil drain pan shall disable the unit whenever enabled. Unit must be manually restarted.
- D. Provide a duct smoke detector in each unit 2,000 CFM or over in the return air connection and in the supply air ductwork.
- E. Fire alarm shutdown – If the duct smoke detectors sense smoke, then any combination fire/smoke dampers shall close and the associated unit shall be de-energized. The unit shall not be permitted to operate until all trouble signals are cleared on the fire alarm system.
- F. Ventilation air - during occupied hours, the outside air damper shall be open. During the evening hours and unoccupied hours, the outside air damper shall be closed unless unoccupied cooling can be achieved via economizer.
- G. Air-side economizer - when the outside air temperature is lower than the space air temperature and the outside air dewpoint temperature is below 55°F, the unit shall operate in 100% outside air mode with no mechanical cooling. ATC contractor to integrate remote relief air controls.
- H. Integrate with the BAS.

4.04 VAV BOX WITH ELECTRIC HEAT (NO FAN)

- A. VAV boxes shall be provided with an open protocol BACNET controller with morning warm-up controls.
- B. VAV boxes shall be provided with wall mounted space sensors (as shown on the plans) with override.
- C. Operation
 1. Occupied cooling - on a call for cooling, the VAV box primary air valve shall modulate to satisfy the space setpoint temperature.
 2. Occupied heating - on a call for heating, the VAV box primary air valve shall modulate to the heating CFM position and the VAV box reheat coil shall be staged to satisfy the space setpoint temperature.
 3. Unoccupied cooling - on a call for cooling, the VAV box primary air valve shall modulate to satisfy the unoccupied space setpoint temperature.
 4. Unoccupied heating - on a call for heating, the VAV box primary air valve shall be locked at the minimum position and heating shall be provided by the VAV box heating coil.
 5. Integrate VAV box controls with associated air handling unit and associated VFD controls.
 6. Carbon Dioxide Reset (if shown on the plans)
 - a. Sensor shall be installed in a protective cover (clear plastic with locking cover). Coordinate final location with engineer.
 - b. On a rise in carbon dioxide levels above the set point (700 PPM) the primary air damper shall gradually open.
 - c. On a fall in carbon dioxide levels below the set point, the primary air damper shall gradually close down to the minimum position.
 - 1) The minimum quantity of outdoor air shall not fall below that determined from the area outdoor airflow rate (refer to ventilation schedule) during periods when the building is expected to be occupied.
 - d. Integrate with the BAS.

D. Integrate with the BAS.

4.05 FAN POWERED VAV BOX WITH ELECTRIC REHEAT

A. General

1. VAV boxes shall be provided with an open protocol BACNET controller with morning warm-up controls.
2. VAV boxes shall be provided with wall mounted space sensors (as shown on the plans) with override.

B. Operation

1. Occupied cooling - on a call for cooling, the VAV box primary air valve shall modulate to satisfy the space setpoint temperature. Once the cooling requirements of the space are met, the VAV box primary air valve shall modulate to maintain the minimum cooling supply air CFM setpoint and the VAV box supply fan shall modulate to maintain constant volume in the space.
2. Occupied heating - on a call for heating, the VAV box primary air valve shall modulate to the heating CFM position listed on the floor plans and the VAV box supply fan shall provide the heating CFM. The electric heating coil shall stage the electric heat to satisfy the space setpoint temperature.
3. Unoccupied cooling - on a call for cooling, the VAV box primary air valve shall modulate to satisfy the unoccupied space setpoint temperature.
4. Unoccupied heating - on a call for heating, the VAV box primary air valve shall be closed and the heating shall be provided by the VAV box supply fan and electric reheat coil.
5. Integrate VAV box controls with associated air handling unit and associated VFD controls.
6. Carbon Dioxide Reset (if shown on the plans)
 - a. Sensor shall be installed in a protective cover (clear plastic with locking cover). Coordinate final location with engineer.
 - b. On a rise in carbon dioxide levels above the set point (700 PPM) the primary air damper shall gradually open.
 - c. On a fall in carbon dioxide levels below the set point, the primary air damper shall gradually close down to the minimum position.
 - 1) The minimum quantity of outdoor air shall not fall below that determined from the area outdoor airflow rate (refer to ventilation schedule) during periods when the building is expected to be occupied.
 - d. Integrate with the BAS.

C. All VAV boxes shall be grouped in time-of-day zones indexed globally by the new BAS controller and according to the time-of-day schedule for the air handling unit serving them. During the occupied mode (based on time-of-day schedule as specified by the owner (adjustable) and indexed through the central BAS controller), the VAV boxes in each zone shall be indexed to "occupied".

D. The supply air damper is controlled with minimum and maximum CFM settings. The VAV box controller will monitor the room temperature sensor and the air velocity sensor. The controller will modulate the damper, the recirculating air damper, and stage the electric heat to maintain the desired room temperature. The controller energizes the fan based on the current occupancy mode.

E. Occupied Mode: The fan runs continuously during cooling and heating.

1. Cooling Operation: The room temperature is compared to the cooling setpoint. The controller will modulate the primary air damper and the recirculated air damper in sequence to maintain the cooling setpoint and energize the supply fan. The supply air volume will be limited by the minimum and maximum primary air volume settings. The heat will be off.
 2. Heating Operation: The room temperature is compared to the heating setpoint. The controller will stage the electric heat to maintain the heating setpoint. The primary air volume damper is set to minimum and the recirculated plenum air is set to maximum.
- F. Unoccupied Mode; Upon a command from the BAS panel to change over to unoccupied mode, the VAV box controller will control using the night heating and cooling setpoints. The fan will cycle on and off to maintain the minimum temperature setback. The primary air valve shall be tightly closed.
- G. Integrate with the BAS

4.06 DUCTLESS SPLIT SYSTEM

- A. General
1. The indoor unit shall be furnished with a wireless, wall mounted programmable 24 hr./7-day thermostat. ATC contractor shall install and wire thermostat.
 2. ATC contractor shall wire outdoor unit to the indoor unit.
 3. The unit shall include a low ambient kit. ATC contractor shall wire the outside air temperature sensor.
 4. The units shall be circuited to standby power.
 5. Ductless split system to be furnished with a BACNET network card.
 6. Integrate with the BAS.
- B. Operation
1. Cooling - on a call for cooling, the indoor unit shall operate to maintain 72°F (adj.) In the space.
 2. Heating - on a call for heating, the indoor unit shall operate to maintain 60°F (adj.) In the space.
- C. Integrate with the BAS

4.07 EXHAUST FANS

- A. General:
1. Provide a 24 hr./7 day time clock which shall start and stop the toilet room exhaust fans according to the schedule directed by the owner. Contactors and relays shall be provided by the ATC Contractor. The toilet room exhaust fans shall be controlled by the BAS.
 2. Fan status (on/off) and start/stop points shall be shown on the BAS workstation.
 3. 0-10V speed controllers shall be furnished with each exhaust fan listed in the equipment schedule for balancing purposes.
- B. Operation:
1. EF-1,2,3 (toilet rooms) - the fan shall run continuously during occupied hours and be off during unoccupied hours.
 2. EF-4 (janitors room) - the exhaust fan(s) shall operate 24/7/365.
 3. EF-EL1, EL2 (elevator shafts) - the fan shall operate when the space temperature rises above 90°F. An alarm signal shall be sent to the BAS if the room temperature exceeds 100°F.

4. EF-L (loading dock ventilation) - the fan(s) shall be interlocked with the motor operated damper(s) on gravity ventilator. The fan(s) shall operate when the space CO sensors read levels higher than 25 ppm. An alarm signal shall be sent to the BAS if the CO levels exceed 35 ppm.
5. EF-MS (maker space) – the fan shall be controlled by a wall or hood mounted switch.
- C. Refer to exhaust fan schedule for specific controls descriptions.
- D. Integrate all fans with the BAS. The following monitoring points shall be available:
 1. Fan Status ON/OFF
 2. Alarm
 3. Override ON/OFF
 4. Schedule of Operation.

4.08 SMOKE DAMPERS (SD) AND COMBINATION FIRE/SMOKE DAMPERS (FSD)

- A. Smoke dampers (SD) and combination fire/smoke dampers (FSD) shall be furnished by the mechanical contractor and installed by the mechanical contractor (or sheet metal sub-contractor). The electrical contractor shall provide 120V power to all smoke dampers and combination fire/smoke dampers (refer to electrical drawings). The fire alarm sub-contractor shall wire the smoke damper or combination fire/ smoke damper to the digital addressable fire alarm system.
- B. Refer to cover sheet or equipment schedules for smoke damper and combination fire/smoke damper specification. Smoke dampers and combination fire/smoke dampers shall be power open, spring closed type (fail closed).
- C. Smoke dampers and combination fire/smoke dampers shall be furnished with open / closed blade indication module (OCI). The fire alarm sub-contractor shall wire the OCI module to the addressable fire alarm system.
- D. Addressable duct mounted smoke detectors or full area smoke detection shall be provided for each smoke damper and combination fire/smoke damper in accordance with international mechanical code section 607.3.3.
- E. The addressable duct mounted smoke detectors shall be furnished by the fire alarm sub-contractor, mounted by the mechanical contractor (or sheet metal sub-contractor) and wired to the addressable fire alarm system by the fire alarm sub-contractor.
- F. Do not integrate with the BAS.

4.09 SMOKE DAMPERS (AHU'S OVER 15,000 CFM)

- A. All air-handling units serving more than one (1) floor and have a fan capacity of 15,000 CFM or greater must be provided with an integral smoke damper(s) to isolate the unit from the air distribution system. ATC contractor shall wire the smoke damper end switches to the air handling unit fan control. Integrate with the fire alarm system.
- B. Integrate with the BAS.

4.10 SUSPENDED UNIT HEATERS – ELECTRIC

- A. General - refer to equipment schedule for additional information.
- B. Provide a wall mounted thermostat which shall start and stop the unit heater to maintain space temperatures. Fan shall start and stop with heating element.
- C. Wiring of thermostat is control wiring to be provided by the Mechanical/ATC Contractor regardless of line or low voltage.

- D. Provide an integral thermostat which shall energize and de-energize the unit heater and associated fan to maintain space setpoint temperature.
- E. Do not integrate with the BAS.

4.11 CABINET UNIT HEATERS - ELECTRIC

- A. General – Refer to equipment schedule for additional information.
- B. Provide an integral thermostat or wall mounted which shall energize and de-energize the electric radiation to satisfy space setpoint temperatures. Wiring the thermostat is control wiring to be provided by the Mechanical/ATC Contractor regardless of line or low voltage.
- C. Cabinet unit heaters in public areas such as stair towers, lobbies and vestibules shall be furnished with integral tamperproof unit mounted thermostats.
- D. Cabinet unit heaters in mechanical rooms, electrical rooms and other back-of-house areas shall be furnished with wall mounted thermostats unless noted otherwise.
- E. Do not integrate with the BAS.

4.12 CONVECTORS, EXTENDED FIN RADIATION – ELECTRIC

- A. General - Refer to equipment schedule for additional information.
- B. Provide an integral or wall mounted thermostat which shall energize and de-energize the heating element to satisfy space setpoint temperatures.
- C. Wiring of thermostat is control wiring to be provided by the Mechanical/ATC Contractor regardless of line or low voltage.
- D. Provide an integral thermostat which shall energize and de-energize the radiation to satisfy space setpoint temperatures.
- E. Do not integrate with the BAS.

4.13 DUCT MOUNTED SMOKE DETECTORS

- A. In air systems with a capacity greater than 2,000 CFM, furnish and install duct mounted smoke detectors in the supply air (downstream the air filters and upstream of any branch duct) and return air ductwork.
- B. In multi-story buildings at each story with a commonly shared return and having a capacity greater than 15,000 CFM's furnish and install smoke detectors before the connection to the common return and before any connection to any recirculation or fresh air inlet in the return air systems. This includes plenums where the plenum is used for a common return.
- C. The fire alarm sub-contractor shall furnish a fire alarm monitoring module for each required air handling system. The ATC Contractor shall wire the fire alarm monitoring module to the emergency shutdown contacts or combination motor starter/disconnect on each air handling system.
- D. Detectors shall de-energize the unit and signal the addressable fire alarm system if smoke is detected.
- E. Detectors shall be accessible. Mechanical contractor shall be responsible for providing all necessary access panels and doors.
- F. Duct smoke detectors to be furnished by the Electrical Contractor.
- G. Integrate with the BAS.

END OF SECTION

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Refrigerant pipes and fittings.
 - 2. Refrigerant piping valves and specialties.
 - 3. Refrigerants.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of valve, refrigerant piping, and refrigerant piping specialty.
- B. Sustainable Design Submittals:
 - 1. Product Data for EA Prerequisite 3, "Fundamental Refrigerant Management": For refrigerants, indicating compliance with refrigerant management practices.
- C. Shop Drawings:
 - 1. Show piping size and 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.
 - 2. Show interface and spatial relationships between piping and equipment.
 - 3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-454B:
 - 1. Suction Lines for Air-Conditioning Applications: per manufacturer recommendations.

2. Suction Lines for Heat-Pump Applications: per manufacturer recommendations
3. Hot-Gas and Liquid Lines: per manufacturer recommendations

2.02 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B)
- 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/A5.8M.
- 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. Working Pressure Rating: Factory test at minimum 500 psig.
 5. Maximum Operating Temperature: 250 deg. F.

2.03 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker - Sporlan Hannifin Corp.
 - d. Paul Mueller Company.
 2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 4. Operator: Rising stem and hand wheel.
 5. Seat: Nylon.
 6. End Connections: Socket, union, or flanged.
 7. Working Pressure Rating: 500 psig.
 8. Maximum Operating Temperature: 275 deg. F.
- B. Packed-Angle Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker - Sporlan Hannifin Corp.
 - d. Paul Mueller Company.
 2. Body and Bonnet: Forged brass or cast bronze.
 3. Packing: Molded stem, back seating, and replaceable under pressure.
 4. Operator: Rising stem.
 5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
 6. Seal Cap: Forged-brass or valox hex cap.
 7. End Connections: Socket, union, threaded, or flanged.
 8. Working Pressure Rating: 500 psig.

9. Maximum Operating Temperature: 275 deg. F.
- C. Check Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
 2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 4. Piston: Removable polytetrafluoroethylene seat.
 5. Closing Spring: Stainless steel.
 6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 7. End Connections: Socket, union, threaded, or flanged.
 8. Maximum Opening Pressure: 0.50 psig.
 9. Working Pressure Rating: 500 psig.
 10. Maximum Operating Temperature: 275 deg. F.
- D. Service Valves:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
 - f. Refrigeration Sales, Inc.
 2. Body: Forged brass with brass cap including key end to remove core.
 3. Core: Removable ball-type check valve with stainless-steel spring.
 4. Seat: Polytetrafluoroethylene.
 5. End Connections: Copper spring.
 6. Working Pressure Rating: 500 psig.
- E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
 2. Body and Bonnet: Plated steel.
 3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 4. Seat: Polytetrafluoroethylene.
 5. End Connections: Threaded.
 6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and [24] [115] [208]-V ac coil.
 7. Working Pressure Rating: 400 psig.
 8. Maximum Operating Temperature: 240 deg. F.
- F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker - Sporlan Hannifin Corp.
 - d. Paul Mueller Company.
2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
3. Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg. F.
- G. Thermostatic Expansion Valves: Comply with AHRI 750.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Parker - Sporlan Hannifin Corp.
 2. Body, Bonnet, and Seal Cap: Forged brass or steel.
 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 6. Suction Temperature: 40 deg. F
 7. Superheat: Adjustable
 8. Reverse-flow option (for heat-pump applications).
 9. End Connections: ODF female, sweat connection, flare.
 10. Equalizer: External
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker -sporlan Hannifin Corp.
 2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 6. Seat: Polytetrafluoroethylene.
 7. Equalizer: External
 8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and 120-V ac coil.
 9. End Connections: Socket. ODF female, sweat connection, flare.
 10. Throttling Range: Maximum 5 psig.
 11. Working Pressure Rating (max): 700 psig.
 12. Maximum Operating (fluid) Temperature: 240 deg. F.
 13. Max ambient Temperature: 120 deg. F
- I. Straight-Type Strainers:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.

- c. Parker Hannifin Corp.
 - 2. Body: Welded steel with corrosion-resistant coating.
 - 3. Screen: 100-mesh stainless steel.
 - 4. End Connections: Socket or flare.
 - 5. Working Pressure Rating: 500 psig.
 - 6. Maximum Operating Temperature: 275 deg. F.
- J. Angle-Type Strainers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Heldon Products; Henry Technologies.
 - c. Parker Hannifin Corp.
 - 2. Body: Forged brass or cast bronze.
 - 3. Drain Plug: Brass hex plug.
 - 4. Screen: 100-mesh monel.
 - 5. End Connections: Socket or flare.
 - 6. Working Pressure Rating: 500 psig.
 - 7. Maximum Operating Temperature: 275 deg. F.
- K. Moisture/Liquid Indicators:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker – Sporlan Hannifin Corp.
 - 2. Body: Forged brass.
 - 3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 - 4. Indicator: Color coded to show moisture content in parts per million (ppm).
 - 5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 - 6. End Connections: Socket or flare.
 - 7. Working Pressure Rating: 650 psig
 - 8. Maximum Operating Temperature: 240 deg. F.
- L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker Hannifin Corp.
 - 2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 - 3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 - 4. Desiccant Media: Molecular sieve, Activated alumina.
 - 5. End Connections: Socket.
 - 6. Access Ports: NPS 1/4-inch connections at entering and leaving sides for pressure differential measurement.
 - 7. Maximum Pressure Loss: 2 psig
 - 8. Working Pressure Rating: 650psig
 - 9. Maximum Operating Temperature: 240 deg. F.
- M. Permanent Filter Dryers: Comply with AHRI 730.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies.
 - c. Heldon Products; Henry Technologies.
 - d. Parker – Sporlan Hannifin Corp.
2. Body and Cover: Painted-steel shell.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Molecular sieve, Activated alumina.
5. End Connections: Socket
6. Maximum Pressure Loss: 2 psig
7. Working Pressure Rating: 650 psig
8. Maximum Operating Temperature: 240 deg. F.

PART 3 - EXECUTION

3.01 REFRIGERANT PIPING APPLICATIONS

- A. Suction Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR or Type L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, Type K (A) or Type L (B), drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, Type K (A), or Type L (B), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- F. Safety-Relief-Valve Discharge Piping: Copper, Type ACR or Type L (B), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- G. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- H. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, Type K (A), Type L (B), drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- I. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, Type K (A) or Type L (B), drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle 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 or packed-angle valves on inlet and outlet side of filter dryers.
- E. Install a full-size, 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 downstream of the bulb location where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by 2010 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 the 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 condenser 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 (Vibration absorbers) at compressors.

3.03 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 Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" 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 Section 083113 "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. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.04 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. 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.

3.05 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "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 diameters:
 1. NPS 1/2-inch: Maximum span, 60 inches; minimum rod, 1/4 inch.
 2. NPS 5/8-inch: Maximum span, 60 inches; minimum rod, 1/4 inch.
 3. NPS 1-inch: Maximum span, 72 inches; minimum rod, 1/4 inch.
 4. NPS 1 1/4 -inch: Maximum span, 96 inches; minimum rod, 3/8 inch.
 5. NPS 1 1/2 -inch: Maximum span, 96 inches; minimum rod, 3/8 inch.
 6. NPS 2-inch: Maximum span, 96 inches; minimum rod, 3/8 inch.
 7. NPS 2 1/2 -inch: Maximum span, 108 inches; minimum rod, 3/8 inch.
 8. NPS 3-inch: Maximum span, 10 feet; minimum rod, 3/8 inch.
 9. NPS 4-inch: Maximum span, 12 feet; minimum rod, 1/2 inch.
- D. Support multifloor vertical runs at least at each floor.

3.06 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Comply with ASME B31.5, Chapter VI.
 2. Comply with ASHRAE Standard 15, section 9.13
 3. 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.
 4. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "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.
- B. Prepare test and inspection reports.

3.07 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.

3.08 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. 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.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Rectangular ducts and fittings.
 - 2. Round ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Sound attenuating duct lining.
 - 5. Sealants and gaskets.
 - 6. Hangers and supports.
- B. Related Sections:
 - 1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Section 233119 "HVAC Casings" for factory and field fabricated casings for mechanical equipment.
 - 3. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.02 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ANSI/ASHRAE 62.1.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Submittals:
 - 1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 - 2. Product Data: For adhesives, indicating VOC content.
 - 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 4. Product Data: For sealants, indicating VOC content.
 - 5. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
- C. Shop Drawings:
 - 1. Ductwork shop drawings must be properly submitted. Any ductwork installed without prior approval by the engineer and found to be incorrect, shall be replaced at the expense of the contractor.
 - 2. Submit shop drawings of all sheet metal for review. Drawings shall be not less than 1/4" scale and show all light fixtures, steel, piping, conduit, equipment and

architectural features. It is unacceptable to resubmit and modify McHugh design documents for sheet metal drawing purposes.

- a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
- b. Factory- and shop-fabricated ducts and fittings.
- c. Duct layout indicating sizes, configuration, CFM, and static-pressure classes.
- d. Elevation of top of ducts. Verify ductwork fits in available space.
- e. Dimensions of main duct runs from building grid lines.
- f. Fittings.
- g. Reinforcement and spacing.
- h. Seam and joint construction.
- i. Penetrations through fire-rated and other partitions.
- j. Equipment
- k. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
- l. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- m. Indicate waste and storm piping where it occurs in the area of ductwork.
- n. Locate electrical gear on plan. Ductwork is not to run above panels.
- o. Ductwork is to be shown double line with indicated width and height.
- p. Allowance to be made for lining and/or insulation.
- q. Duct sizes shown on contract drawings may be flattened to a 4 to 1 ratio when necessary to establish clearance. Such transitions are to be included in the contract price.
- r. Ductwork fabrication shall not proceed until shop drawings are submitted for review.
- s. All dampers, grilles, registers, diffusers, access panels, louvers, coils, filters, and other components of the system are to be indicated.
- t. Provide detail of fire damper assembly.
- u. Provide drawing sections when requested by the engineer.
- v. Coordinate sheet metal drawings with light fixture layout and sprinkler system piping and heads and shown on the drawing.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.

- 5. Penetrations of smoke barriers and fire-rated construction.
 - 6. Items penetrating finished ceiling including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
 - B. Welding certificates.
- 1.05 QUALITY ASSURANCE
- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
 - B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
 - C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 RECTANGULAR DUCTS AND FITTINGS – SMACNA STANDARDS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Rectangular ductwork above the roof or outside shall be 4" water gauge construction.

2.02 FABRICATED DUCT REQUIREMENTS - DUCTMATE

- A. All interior rectangular ducts shall be constructed with G-60 or better galvanized steel (ASTM A-653-94) LFQ, chem treat. Exterior ductwork shall be G-90 or better galvanized steel LFQ, chem treat. Kitchen, shower, or dishwasher exhaust shall be aluminum with aluminum joints.
- B. Materials: Support, access doors not part of ducts, bar or angle reinforcing damper rods and items made of uncoated mild steel shall be painted with two coats of primer or provide galvanized equivalent.
- C. Longitudinal Seams. Pittsburgh lock shall be used on all longitudinal seams. All longitudinal seams will be sealed with mastic sealant. Snaplock is not acceptable.
- D. Flanged interior Gasket. Ductmate 440 or a Butyl Rubber Gasket which meets Mil-C 18969B, Type II Class B, TT-C-1796 A, Type II Class B, and TTS-S-001657 must also pass UL-723. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type of vehicle that will support fungal and/or bacterial growth associated with dark, damp areas of ductwork. The recommended test procedure for bacterial and fungal growth is found in 21CFR 177, 1210 closures with sealing gaskets for food containers.
- E. Ductmate or W.D.C.I. proprietary duct connection systems will be accepted. Duct constructed using these systems will refer to the manufacturers guidelines for sheet gauge, intermediate reinforcement size and spacing, and joint reinforcements.
- F. Formed - on flanges (T.D.C./T.D.F./T-25A/T-25B) be accepted. Formed on flanges will be constructed as SMACNA T-25 flanges, whose limits are defined on page 1.36 1995 SMACNA Manual, Second Edition. No other construction pertaining to formed - on flanges will be accepted. Formed on flanges shall be accepted for use on ductwork 42" wide or less and must include the use of corners, bolts, and cleat. (Over 42", the reinforcement/joint deflection criteria no longer conform with the UMC).
- G. Rectangular ductwork above the roof or outside shall be 4" water gauge construction.

2.03 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ductmate Industries, Inc.
 - b. Elgen Manufacturing.
 - c. Linx Industries (formerly Lindab).
 - d. McGill AirFlow LLC.
 - e. MKT Metal Manufacturing.
 - f. SEMCO LLC.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.04 SOUND ATTENUATING DUCT LINING

A. Includes:

1. All interior exposed supply air ductwork in public areas.
2. All interior return ductwork.
3. All transfer air ductwork.
4. No kitchen supply and return ductwork shall be lined.

NOTE: Refer to ductwork insulation specification (23 07 13) for insulation requirements. Lining indicated is in addition to insulation requirements.

- B. Duct liner shall have a flame spread of not over 25, a fuel contributed of not over 50 and a smoke developed of not over 50.
- C. Liner shall be minimum 1 inch thick, 1.5 Lbs./Cu. Ft. density with a thermal conductance of .24 at 50 deg. F. mean temperature. (Conductance: BTU/Sq. Ft./F/Hr.).
- D. Liner shall not spall or deteriorate at air velocities to 4000 FPM when installed in accordance with the manufacturer's recommendations.
- E. Liner shall be Johns-Manville Linacoustic or approved substitute by Owens-Corning, CertainTeed, or Knauf. Observe all installation instructions.
- F. Any ductwork in unconditioned spaces or outdoors shall have insulation totaling R-8.3.

2.05 SHEET METAL MATERIALS

- A. General Material Requirements: 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: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation For Interior Ductwork: G60. Paintable duct to be G90.
 2. Galvanized Coating Designation For Exterior Ductwork: G90.
 3. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. 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.
- G. Fiberglass ductboard is not acceptable.

2.06 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 8. Service: Indoor or outdoor.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 7. Sealant 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."
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.07 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc

chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts at a minimum to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.04 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.07 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 - 1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.
- B. Supply Ducts:
 - 1. All Supply Ductwork:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: C for 0-2"; B for 3"; A for 4", 6", 10".
 - c. SMACNA Leakage Class for Rectangular: 16 for 0-2"; 8 for 3"; 4 for 4", 6", 10".
 - d. SMACNA Leakage Class for Round and Flat Oval: 8 for 0-2"; 4 for 3"; 2 for 4", 6", 10".
- C. Return Ducts:
 - 1. All Return Ductwork:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- D. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
 - 2. All Other Return Air Ductwork:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- F. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
- G. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards -

Metal and Flexible," Figure 4-2, "Rectangular Elbows."

- a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- H. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.

- b. Velocity 1000 to 1500 fpm: Conical tap.
- c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Manual volume dampers.
 - 3. Control dampers.
 - 4. Fire dampers.
 - 5. Smoke dampers.
 - 6. Flange connectors.
 - 7. Turning vanes.
 - 8. Duct-mounted access doors.
 - 9. Flexible connectors.
 - 10. Duct accessory hardware.
- B. Related Requirements:
 - 1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
 - 2. Section 283000 "Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product data showing compliance with ASHRAE 62.1.
 - 2. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - e. Wiring Diagrams: For power, signal, and control wiring.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. 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.

2.02 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 for indoor applications and G90 for exterior applications.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and <Insert finish designation> finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. 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: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a Mestek Architectural Group company.
 - 2. Greenheck Fan Corporation.
 - 3. Lloyd Industries, Inc.
 - 4. Nailor Industries Inc.
 - 5. NCA Manufacturing, Inc.
 - 6. Pottorff.
 - 7. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2500 fpm.
- D. Maximum System Pressure: 2-inch wg
- E. Maximum Pressure Drop Across the Damper: .2"wg
- F. Frame: Hat-shaped, 0.063-inch-thick extruded aluminum or 0.05-inch-thick stainless steel, with welded corners or mechanically attached and mounting flange.
- G. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.
- H. Blade Action: Parallel.
- I. Blade Seals: Extruded vinyl, mechanically locked or Neoprene, mechanically locked.
- J. Blade Axles:
 - 1. Material: Stainless steel.
 - 2. Diameter: 0.20 inch. minimum
- K. Tie Bars and Brackets: Galvanized steel.
- L. Return Spring: Adjustable tension.
- M. Bearings: Synthetic pivot bushings.
- N. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
 2. Counterweights and spring-assist kits for vertical airflow installations.
 3. Screen Mounting: Rear mounted.
 4. Screen Material: Aluminum.
 5. Screen Type: Insect.
 6. 90-degree stops.
- O. Air Leakage: Class I – Not to exceed 8 CFM/FT² @ 4" w.g. AMCA Certified.

2.04 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Warming and Ventilating; a Mestek Architectural Group company.
 - b. Flexmaster U.S.A., Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Pottorff.
 - f. Ruskin Company.
2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. 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 steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
 - a. Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. 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.

C. 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.

2.05 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the

following:

1. American Warming and Ventilating; a Mestek Architectural Group company.
 2. Arrow United Industries.
 3. Greenheck Fan Corporation.
 4. Lloyd Industries, Inc.
 5. McGill AirFlow LLC.
 6. Metal Form Manufacturing, Inc.
 7. Nailor Industries Inc.
 8. Pottorff.
 9. Ruskin Company.
 10. Tamco
 11. Young Regulator Company.
- B. Frames:
1. Hat, U, or Angle shaped.
 2. 0.05-inch thick stainless steel.
 3. Mitered and welded corners.
- C. Blades:
1. Multiple blade with maximum blade width of 6 inches.
 2. Opposed blade design.
 3. Aluminum.
 4. 0.0747-inch- thick dual skin.
 5. Blade Edging: Closed-cell neoprene.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- D. Blade Axles: 1/2-inch-diameter; nonferrous metal; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg. F.
- E. Bearings:
1. Molded synthetic.
 2. Dampers in ducts with pressure classes of 3-inch wg 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.
- F. Air Leakage: Class I – Not to exceed 8 CFM/FT² @ 4"wg.. AMCA Certified.

2.06 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a Mestek Architectural Group company.
 2. Arrow United Industries.
 3. Greenheck Fan Corporation.
 4. Nailor Industries Inc.
 5. Pottorff.
 6. Ruskin Company.
 7. Vent Products Co., Inc.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2500-fpm velocity.
- D. Fire Rating: 1 ½ and 3 hours. Coordinate with wall rating.
- E. Frame: Curtain type with blades inside airstream for duct heights larger than 14" and curtain type with blades outside airstream for duct heights 14" and below; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.138 inch 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.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg. F rated, fusible links. Provide 10 % extra links to the owner.
- K. SET FIRE DAMPERS IN 20 GAUGE SLEEVES WITH BREAKAWAY CONNECTIONS TO THE DUCTWORK ON EACH SIDE. SEE STANDARD SMACNA DETAILS FOR INSTALLATION. DAMPERS INSTALLED INCORRECTLY WILL BE REQUIRED TO BE REMOVED AND REPLACED CORRECTLY.
- L. Provide 12" x 12" access door in ductwork for access to each damper. Label "FIRE DAMPER ACCESS" with 2" high stenciled letters.

2.07 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a Mestek Architectural Group company.
 2. Greenheck Fan Corporation.
 3. Nailor Industries Inc.
 4. Pottorff.
 5. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: Shall be provided by the Fire Alarm Contractor / Electrical Contractor and installed by the Mechanical Contractor.
- D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with interlocking, gusseted or mechanically attached corners and mounting flange.
- E. Blades: Roll-formed, horizontal, interlocking, 0.063-inch thick, galvanized sheet steel.
- F. Leakage: Class I.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, 0.05-inch thick, galvanized sheet steel; length to suit wall or floor application [with factory-furnished silicone caulking].
- I. Damper Motors: two-position action.
- J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC 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 Section 230923 "Direct Digital Control (DDC) System 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 minus 40 deg. F.
 6. Nonspring-Return Motors: For damper's larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 7. Electrical Connection: 24 V.
- K. Accessories:
1. Auxiliary switches for position indication.
Test and reset switches, damper mounted.

2.08 COMBINATION SMOKE/FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a Mestek Architectural Group company.
 2. Greenheck Fan Corporation.
 3. Nailor Industries Inc.
 4. Pottorff.
 5. Ruskin Company.
- B. General Requirements:
1. Dampers shall be furnished with both the 1 1/2 hour (or 3 hour) UL label for fire dampers - UL 555 and the UL label for leakage resistance (smoke) - UL 555S.
 2. Refer to the requirements of Fire Dampers and Smoke Dampers for additional requirements.

2.09 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
- B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.10 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aero-Dyne Sound Control Co.
 2. Ductmate Industries, Inc.
 3. Duro Dyne Inc.
 4. Elgen Manufacturing.
 5. Hardcast, Inc.
 6. METALAIRE, Inc.
 7. SEMCO LLC.
- 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: Double wall.

2.11 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a Mestek Architectural Group company.
 - 2. Ductmate Industries, Inc.
 - 3. Elgen Manufacturing.
 - 4. Flexmaster U.S.A., Inc.
 - 5. Greenheck Fan Corporation.
 - 6. McGill AirFlow LLC.
 - 7. Nailor Industries Inc.
 - 8. Pottorff.
- 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: Continuous and two compression latches with outside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside handles.

2.12 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M.
 - 2. Ductmate Industries, Inc.
 - 3. Flame Gard, Inc.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.
- D. Fasteners: Stainless 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 wg, positive or negative.

2.13 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Elgen Manufacturing.
 - 3. Hardcast, Inc.
- 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 5 3/4 inches wide attached to two 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: Minus 40 to plus 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.

2.14 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.

2.15 ABOVE THE ROOF DUCT CURBS

- A. Furnish and install - RPS Duct Mounting Pedestals as manufactured by RPS Products and Systems Corp., Bensenville, IL at all necessary specified points or as shown on drawings. The duct mounting pedestal shall include an equipment rail, a matching length steel slide channel attached to "U" shaped mounting brackets and secured to side of equipment rail with lag bolts. The duct mounting assembly shall have galvanized 18' long continuous threaded rods for 12" vertical adjustment, lateral adjust spacer bracket for 12" horizontal adjustment, and galvanized slide assembly.

2.16 VOLUME DAMPER CONTROL - REMOTE EXTERNAL CONTROL

Applications: Drywall ceilings or where shown on drawings.

- 1. Location: In ductwork where required to control air flow or balance air systems.
- 2. Volume Damper Type: Opposed single blade round butterfly damper for external control, EPDM low leakage seals, scoop and spin-in type shell, Young Regulator Co. 5020 CC Series. Rectangular: #830-CC Series.
- 3. Leakage: 10 CFM maximum at 4" s.p. for 4 square dampers.
- 4. Material: Galvanized steel in galvanized steel ductwork, extruded aluminum in aluminum ductwork.

5. Controls: Bowden Cable Control Kit 270-896C to include hardware, for ceiling mounting in conjunction with external control of round or rectangular dampers, flush 7/8" diameter cold rolled steel cover is zinc plated for painting, 12" wrench (damper adjustments), metal clad control cable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. 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.
- B. 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.
- C. Install backdraft or control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. 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.
 1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. Upstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 6. 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.
 7. At each change in direction and at maximum 50-foot spacing.
 8. Upstream from turning vanes.
 9. Upstream or downstream from duct silencers.
 10. Control devices requiring inspection.
 11. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.

4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- N. Connect diffusers or light troffer boots to ducts with maximum 10 feet lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. Install volume damper control – remote external control when balancing dampers are located above inaccessible ceilings similar to gypsum board.

3.02 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Operate dampers to verify full range of movement.
 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Inspect turning vanes for proper and secure installation.

END OF SECTION

SECTION 23 33 46 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Insulated supply flexible ducts.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For flexible ducts.
 - 1. Include plans showing locations and mounting and attachment details.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. 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.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.02 INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. Flex-Tek Group.
 - 3. McGill AirFlow LLC.
 - 4. Thermaflex.
 - 5. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene [aluminized] vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 10-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg. F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1 - R4.2 in conditioned space, R8.0 in unconditioned space/outdoors.
5. Comply with 25/50 flame spread and smoke density ratings.

2.03 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install flexible ducts 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.
- B. Applies to supply ductwork only. Exhaust and return ductwork to be rigid ductwork.
- C. Flexible air connectors and flexible ducts shall not be used to make 90 degree or greater.
- D. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- E. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- F. Connect diffusers or light troffer boots to ducts with maximum 10'-0" lengths of flexible duct clamped or strapped in place.
- G. Connect flexible ducts to metal ducts with liquid adhesive plus tape.
- H. Install duct test holes where required for testing and balancing purposes.
- I. Installation:
1. Install ducts fully extended.
 2. Do not bend ducts across sharp corners.
 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 5. Install flexible ducts in a direct line, without sags, twists, or turns.
- J. Supporting Flexible Ducts:
1. Suspend flexible ducts with bands 1 ½ inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
 4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION

SECTION 23 34 16 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: For each product.
 - 1. Backward-inclined centrifugal fans.
 - 2. Forward-curved centrifugal fans.

1.02 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include rated capacities, furnished specialties, and accessories for each fan.
 - 2. Certified fan performance curves with system operating conditions indicated.
 - 3. Certified fan sound-power ratings.
 - 4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 5. Material thickness and finishes, including color charts.
 - 6. Dampers, including housings, linkages, and operators.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

- A. Belts: Two set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Refer to drawings for performance requirements.

2.02 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Manufacturing Corp.
 2. Greenheck Corporation
 3. Loren Cook Company.
 4. New York Blower Company (The).
- B. Description:
1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 3. Factory-installed and -wired disconnect switch.
- C. Housings:
1. Formed panels to make curved-scroll housings with shaped cutoff.
 2. Panel Bracing: Steel angle or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 3. Horizontally split, bolted-flange housing.
 4. Spun inlet cone with flange.
 5. Outlet flange.
- D. Backward-Inclined Wheels:
1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
 2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.
- E. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
- G. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
 2. Service Factor Based on Fan Motor Size: 1.5.
 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 4. 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.
- 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
- 6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
- 7. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
 - 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 - 2. Scroll Drain Connection: NPS 1-inch steel pipe coupling welded to low point of fan scroll.
 - 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 - 4. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
 - 5. Inlet Screens: Grid screen of same material as housing.
 - 6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
 - 7. Spark-Resistant Construction: AMCA 99.
 - 8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 - 9. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.03 FORWARD-CURVED CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme Engineering & Manufacturing Corp.
 - 2. Greenheck Corporation
 - 3. Loren Cook Company.
 - 4. New York Blower Company (The).
- B. Description:
 - 1. Factory fabricated, assembled, tested, and finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 - 2. Deliver fans as factory assembled units, to the extent allowable by shipping limitations.
 - 3. Factory installed and wired disconnect switch.
- C. Housings:
 - 1. Formed panels to make curved-scroll housings with shaped cutoff.
 - 2. Panel Bracing: Steel angle or channel iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 3. Horizontally split, bolted-flange housing.
 - 4. Spun inlet cone with flange.
 - 5. Outlet flange.
- D. Forward-Curved Wheels:
 - 1. Black-enameled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.
 - 2. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate

- and fastened to shaft with set screws.
- E. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
- G. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
 2. Service Factor Based on Fan Motor Size: 1.5.
 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 4. 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.
 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 7. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
 2. Scroll Drain Connection: NPS 1-inch steel pipe coupling welded to low point of fan scroll.
 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 4. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
 5. Inlet Screens: Grid screen of same material as housing.
 6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
 7. Spark-Resistant Construction: AMCA 99.
 8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 9. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.04 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant

Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
 - 1. Install centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in the architectural specifications.
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. [Secure units to curb support with anchor bolts.]
- F. Unit Support: Install centrifugal fans level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
- G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration isolation devices.
 - 1. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
 - 2. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
- H. Install units with clearances for service and maintenance.
- I. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 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. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
 10. Remove and replace malfunctioning units and retest as specified above.
 11. Kitchen exhaust fan shall be installed within the requirements of NFPA.
 12. Any steel shall be primed with Rustoleum and coated with 2 coats of enamel paint.
- B. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Centrifugal roof ventilators.
2. Centrifugal wall ventilators.
3. In-line centrifugal fans.

1.02 ACTION SUBMITTALS

- A. Product Data:** For each type of product indicated.
- B. Shop Drawings:** 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.
 3. 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.
 4. Design Calculations: Calculate requirements for selecting vibration isolators for designing vibration isolation bases.

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.**

1.04 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. AMCA Compliance:** Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers:** Greenheck Fan Corporation, Loren Cook, PennBarry Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
1. Upblast Units (Where indicated on drawings): Provide spun-aluminum discharge

- 2. baffle to direct discharge air upward, with rain and snow drains.
- 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 5. Fan and motor isolated from exhaust airstream.
- D. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Provide variable frequency drive (VFD). The motor shall be rated for use with a VFD.
 - 3. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 4. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
 - 5. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 6. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. Dampers shall be insulated low leakage.
- E. Roof Curbs: Galvanized steel; 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 suit roof opening and fan base.
 - 1. Overall Height: 8 inches.
 - 2. Sound Curb: Curb with sound-absorbing insulation.
 - 3. Pitch Mounting: Manufacture curb for roof slope.
 - 4. Metal Liner: Galvanized steel.
 - 5. Mounting Pedestal: Galvanized steel with removable access panel.
 - 6. Vented Curb: Unlined with louvered vents in vertical sides.

2.02 CENTRIFUGAL WALL VENTILATORS

- A. Manufacturers: Greenheck Fan Corporation, Loren Cook, PennBarry.
- B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
- C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- D. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 5. Fan and motor isolated from exhaust airstream.
- E. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Provide variable frequency drive (VFD). The motor shall be rated for use with a VFD.
 - 3. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.

4. Bird Screens: Removable, 1/2-inch mesh, aluminum, or brass wire.
5. Wall Grille: Ring type for flush mounting.
6. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
7. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops. Dampers shall be insulated low leakage.

2.03 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Greenheck Fan Corporation, Loren Cook, PennBarry.
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel and inlet cone.
- D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- F. Accessories:
 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Provide variable frequency drive (VFD). The motor shall be rated for use with a VFD.
 3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 4. Companion Flanges: For inlet and outlet duct connections.
 5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 6. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.04 PROPELLER FANS

- A. Manufacturers: Greenheck Fan Corporation, Loren Cook, PennBarry
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.
- C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- D. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- E. Fan Drive: Motor mounted in airstream; factory wired to disconnect switch located on outside of fan housing.
- F. Fan Drive:
 1. Resiliently mounted to housing.
 2. Statically and dynamically balanced.
 3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 4. Extend grease fitting to accessible location outside of unit.
 5. Service Factor Based on Fan Motor Size: 1.4.
 6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.

8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 9. 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.
 10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories:
1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
 2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
 3. Wall Sleeve: Galvanized steel to match fan and accessory size.
 4. Weathershield Hood: Galvanized steel to match fan and accessory size.
 5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
 6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 7. Provide variable frequency drive (VFD). The motor shall be rated for use with a VFD.
 8. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.05 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC 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.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.06 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment Mounting:
1. Install power ventilators on cast-in-place concrete equipment base(s).
 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. Refer to architectural specification sections for installation of roof curbs.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

- D. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in "Section 230548.13 "Vibration Controls for HVAC."
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- G. The ceiling exhaust fan shall be supported from construction above, not ceiling tiles or ceiling runners or grids. Connect to ductwork and extend ductwork to the perimeter of the building.
- H. Each fan shall be connected to ductwork with a flexible connection.
- I. Kitchen exhaust fan shall be installed within the requirements of NFPA.
- J. Any steel shall be primed with Rustoleum and coated with 2 coats of enamel paint.

3.02 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to electrical specifications.
- D. Connect wiring according to electrical specifications.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: On systems greater than 5,000 CFM, 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 Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.
 - 2. Series, fan-powered air terminal units.
 - 3. Casing liner.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For air terminal units.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

1.03 INFORMATIONAL SUBMITTALS

- A. 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:
- B. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.02 BYPASS, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers:
1. Carnes Co.
 2. Krueger-HVAC; brand of Johnson Controls
 3. METALAIRE, Inc.
 4. Nailor Industries Inc.
 5. Titus; brand of Johnson Controls
 6. Tuttle & Bailey
 7. Trane
- B. Configuration: Diverting-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: Galvanized steel, single wall.
1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass or flexible elastomeric duct liner.
- D. Diverter Assembly: Galvanized-steel gate, with polyethylene linear bearings or Aluminum blade, with nylon-fitted pivot point
- E. Multioutlet Attenuator Section: Collars, each with locking butterfly balancing damper.
1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass or flexible elastomeric duct liner.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- F. Hydronic Heating Coils: Copper tube, 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 220 deg F. Include manual air vent and drain valve.
- G. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
1. SCR controlled.
 2. Access door interlocked disconnect switch.
 3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 4. Nickel chrome 80/20 heating elements.
 5. Airflow switch for proof of airflow.
 6. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 7. Magnetic contactor for each step of control (for three-phase coils).
- H. Electric Controls: Damper actuator and thermostat.
1. Damper Actuator: 24 V, powered closed, powered open with microswitch to energize heating control circuit
 2. Thermostat: Wall-mounted electric type with temperature display in Fahrenheit and Celsius, and space temperature set point.
 3. Changeover Thermostat: Duct-mounted, field-adjustable, electric type reverses action of zone thermostat when air temperature reaches 70 deg F.
- Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat. Control devices shall be compatible with temperature controls specified in Section 230933 "Building Automation System."
- and shall have the following features:
4. Damper Actuator: 24 V, powered open, spring or capacitous return.
 5. Thermostat: Wall-mounted electronic type with the following features:
 - a. Temperature set-point display in Fahrenheit and Celsius.

- b. Auxiliary switch to energize heating control circuit.
- c. Changeover thermistor to reverse action.

2.03 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers:
 - 1. Carnes Co.
 - 2. ENVIRO-TEC
 - 3. Johnson Controls, Inc.
 - 4. METALAIRE, Inc.
 - 5. Nailor Industries, Inc.
 - 6. Price Industries
 - 7. Titus; brand of Johnson Controls
 - 8. Trane
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: galvanized steel, single wall.
 - 1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass or flexible elastomeric duct liner.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections, size matching inlet size
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.
- E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 - 2. Damper Position: Normally open
- F. Attenuator Section: 0.034-inch steel sheet
 - 1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass or flexible elastomeric duct liner.
 - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- G. Multioutlet Attenuator Section: Collars, each with locking butterfly balancing damper.
- H. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 - 1. SCR controlled.
 - 2. Access door interlocked disconnect switch.
 - 3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 - 4. Nickel chrome 80/20 heating elements.
 - 5. Airflow switch for proof of airflow.
 - 6. Fan interlock contacts.
 - 7. Fuses in terminal box for overcurrent protection (for coils more than 48 A).

8. Magnetic contactor for each step of control (for three-phase coils).
- I. Control devices shall be compatible with temperature controls system specified in Section 230933 "Building Automation System."
 1. Electric Damper Actuator: 24 V, powered open, spring capacitous return.
 2. Electronic Damper Actuator: 24 V, powered open, spring/capacitous return.
 3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit, and space temperature set point.
 4. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit.
 5. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
 6. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Occupied and unoccupied operating mode.
 - b. Remote reset of airflow or temperature set points.
 - c. Adjusting and monitoring with portable terminal.
 - d. Communication with temperature-control system specified in Section 230933 "Building Automation System."
 7. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
- J. Controls:
 1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
 2. System-powered, wall-mounted thermostat.
- K. Control Sequences:
 1. Refer to Section 230933 "Building Automation System."

2.04 SERIES FAN-POWERED AIR TERMINAL UNITS

- A. Manufacturers:
 1. Carnes Co.
 2. ENVIRO-TEC
 3. Johnson Controls, Inc.
 4. METALAIRE, Inc.
 5. Nailor Industries, Inc.
 6. Price Industries
 7. Titus; brand of Johnson Controls
 8. Trane
- B. Unit casing with control components inside a protective metal shroud for installation above a ceiling and within a raised access floor.
 1. Designed for quiet operation.
 2. Low-profile design.
- C. Casing: galvanized steel, single wall.
 1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass or flexible elastomeric duct liner.
 2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.

3. Air Outlet: S-slip and drive connections.
 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
 5. Fan: Forward-curved centrifugal.
 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 2. Damper Position: Normally open
- E. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.
- F. Motor:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Material: Polyurethane foam having 70 percent arrestance and 3 MERV.
 2. Material: Glass fiber treated with adhesive; having 80 percent arrestance and 5 MERV.
 3. Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
- H. Attenuator Section: 0.034-inch galvanized steel sheet.
1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass or flexible elastomeric duct liner.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- I. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
1. SCR controlled.
 2. Access door interlocked disconnect switch.
 3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 4. Nickel chrome 80/20 heating elements.
 5. Airflow switch for proof of airflow.
 6. Fan interlock contacts.
 7. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 8. Magnetic contactor for each step of control (for three-phase coils).
- J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
 2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 3. Disconnect Switch: Factory-mounted, fuse type.
- K. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

- L. Control devices shall be compatible with temperature controls system specified in Section 230933 "Building Automation System."
1. Electric Damper Actuator: 24 V, powered open, spring or capacitous return.
 2. Electronic Damper Actuator: 24 V, powered open, spring or capacitous return.
 3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
 4. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
 5. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
 6. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
- M. Control Sequences:
1. Refer to Section 230933 "Building Automation System."

2.05 CASING LINER

- A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 2. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
- B. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Minimum Thickness: 3/4 inch.
 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.06 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to AHRI 880.
1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.02 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units' level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.
- D. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- E. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- F. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- G. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."
- H. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 - 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.
- B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

Contractor and Manufacturer Responsibilities:

ITEM	CONNECTED BY	FURNISHED BY	MOUNTED BY
VAV Box	Mechanical Contractor	Mechanical Contractor	Mechanical Contractor
Damper Actuator	ATC Contractor	VAV Mfr.	VAV Mfr.
Air-Flow Pickup	VAV Mfr.	VAV Mfr.	VAV Mfr.
Duct Heater	VAV Mfr.	VAV Mfr.	VAV Mfr.
Safeties	VAV Mfr.	VAV Mfr.	VAV Mfr.
Contactors	VAV Mfr.	VAV Mfr.	VAV Mfr.
Hot Water Coil	VAV Mfr.	VAV Mfr.	Mechanical Contractor
Control Valve	ATC Contractor	Mechanical Contractor	Mechanical Contractor
Valve Actuator		ATC Contractor (4)	ATC Contractor
VAV Box Fan Relay	VAV Mfr.	VAV Mfr.	VAV Mfr.
24-V Transformer (5)	VAV Mfr.	VAV Mfr.	
a. Low Voltage Side			VAV Mfr.
b. Line Voltage Side			See Note 2
Air-Flow Transducer	ATC Contractor	ATC Contractor	See Note 3
Wall Module	ATC Contractor	ATC Contractor	ATC Contractor
Digital Controller	ATC Contractor	VAV Mfr.	Per Above

- (1) Mechanical contractor makes ductwork and piping connections.
- (2) By electrical contractor (preferably) or ATC Contractor, per plans and specs.
- (3) VAV MFR connects air-flow pick-up, ATC Contractor connects wiring (factory mounted and wired on to controller).
- (4) If not integral to control valve.
- (5) If the terminal has no fan, the 24 volt power source should be furnished, mounted, and connected by the ATC Contractor.

3.04 DEMONSTRATION

- A. Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

SECTION 23 37 13.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Louver face diffusers.
 - 3. Linear bar diffusers.
 - 4. Linear slot diffusers.
 - 5. Residential Sidewall/Ceiling Diffusers
 - 6. Louvers
 - 7. Air Filters
 - 8. Sound Traps
 - 9. Drum Louvers
- B. Related Requirements:
 - 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
 - 2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.
 - 3. Section 233713.43 "Security Registers and Grilles" for security registers and security grilles.
 - 4. The SMACNA Low Velocity Duct Manual, ASHRAE Handbooks, International Mechanical Code, and NFPA Pamphlet 90A shall apply to this work.
 - 5. Refer to Section 233113 "Metal Ductwork".

1.02 WORK INCLUDED

- A. Provide labor, material, equipment, and supervision necessary to install a complete air handling system with all supply and return distribution devices as indicated on the drawings and specified herein.
- B. Contractor is to furnish and install a volume damper in all supply, return, exhaust, and outside air branch ductwork. If these are omitted from the drawings, the contractor is to make an allowance to install one.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Submit manufacturer's literature and performance data of equipment and devices for review.
- C. Samples; Furnish at request of A/E.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with manufacturer's warranty requirements.
- B. Provide adequate supervision of labor force to see that installations are correct.

PART 2 - PRODUCTS

2.01 RECTANGULAR AND SQUARE CEILING DIFFUSERS

- A. Furnish and install terminal air diffusers of the size and capacity indicated on the drawings.
- B. Room terminal air velocity shall not exceed 50 fpm. NC level shall not exceed 40. Air static pressure drop shall not exceed 0.10" wg.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat
 - 2. Carnes Company.
 - 3. Hart & Cooley Inc.
 - 4. Krueger.
 - 5. METALAIRE, Inc.
 - 6. Nailor Industries Inc.
 - 7. Price Industries.
 - 8. Titus.
 - 9. Tuttle & Bailey.
- D. Devices shall be specifically designed for variable-air-volume flows.
- E. Material: Steel. Shall be aluminum if located in a damp area similar to a commercial kitchen, locker room, residential bathrooms.
- F. Finish: Baked enamel, white
- G. Face Size: 12 by 12 inches for up to 150 cfm, 24 by 24 inches for all other size.
- H. Face Style: Three cone or Plaque.
- I. Mounting: Each diffuser shall have a mounting flange specifically selected for the particular type of ceiling finish. Contractor to coordinate with architectural ceiling details.
- J. Pattern: Fixed
- K. Dampers: Radial opposed blade
- L. Accessories:
 - 1. Equalizing grid.
 - 2. Plaster ring.
 - 3. Sectorizing baffles.
 - 4. Operating rod extension.
- M. Performance shall be tested in accordance with ASHRAE 70-2006 (RA 2011).

2.02 LOUVER FACE DIFFUSERS

- A. Furnish and install terminal air diffusers of the size and capacity indicated on the drawings.
- B. Room terminal air velocity shall not exceed 50 fpm. NC level shall not exceed 40. Air static pressure drop shall not exceed 0.10" wg
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat
 - 2. Carnes Company.
 - 3. METALAIRE, Inc.
 - 4. Nailor Industries Inc.
 - 5. Price Industries.
 - 6. Titus.

- 7. Tuttle & Bailey.
- D. Devices shall be specifically designed for variable-air-volume flows.
- E. Material: Steel. Shall be aluminum if located in a damp area similar to a commercial kitchen, locker room, residential bathrooms.
- F. Finish: Baked enamel, white
- G. Face Size: 24" x 24"
- H. Mounting: Each diffuser shall have a mounting flange specifically selected for the particular type of ceiling finish. Contractor to coordinate with architectural ceiling details.
- I. Pattern: Fixed
- J. Pattern: One-way, Two-way, Two-way corner, Three-way or Four-way core style.
- K. Dampers: Radial opposed blade
- L. Accessories:
 - 1. Square to round neck adaptor.
 - 2. Adjustable pattern vanes.
 - 3. Throw reducing vanes.
 - 4. Equalizing grid.
 - 5. Plaster ring.
 - 6. Sectorizing baffles.
 - 7. Operating rod extension.
- M. Performance shall be tested in accordance with ASHRAE 70-2006 (RA 2011).

2.03 LINEAR BAR DIFFUSERS

- A. Furnish and install linear type air diffusers of the lengths and capacities indicated on the drawings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat Products; a Mestek company.
 - 2. Carnes Company.
 - 3. Krueger.
 - 4. METALAIRE, Inc.
 - 5. Nailor Industries Inc.
 - 6. Price Industries.
 - 7. Titus.
 - 8. Tuttle & Bailey.
- C. Devices shall be specifically designed for variable-air-volume flows.
- D. Material: Steel. Shall be aluminum if located in a damp area similar to a commercial kitchen, locker room, residential bathrooms.
- E. Finish: Baked enamel, white
- F. Wide Core Spacing Arrangement: 1/8-inch- thick blades spaced 1/2 inch apart; zero degree deflection. Pencil-Proof Core Spacing Arrangement: 3/16-inch- thick blades spaced 7/16 inch apart; zero deflection.
- G. One or Two-Way Deflection Vanes: Extruded construction adjustable louvers with removable core.
- H. Frame: 1 inch wide.
- I. Mounting Frame: Each diffuser shall have a mounting flange specifically selected for the particular type of ceiling finish. Contractor to coordinate with architectural ceiling details.
- J. Mounting: Countersunk screw.
- K. Damper Type: Adjustable opposed-blade assembly
- L. Accessories: Plaster frame for drywall or plaster ceilings

2.04 LINEAR SLOT DIFFUSERS

- A. Furnish and install linear type air diffusers of the lengths and capacities indicated on the drawings.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anemostat Products; a Mestek company.
 - 2. Carnes Company.
 - 3. Hart & Cooley Inc.
 - 4. Krueger.
 - 5. METALAIRE, Inc.
 - 6. Nailor Industries Inc.
 - 7. Price Industries.
 - 8. Titus.
 - 9. Tuttle & Bailey.
- C. Devices shall be specifically designed for variable-air-volume flows.
- D. Material - Shell: Steel. Shall be aluminum if located in a damp area similar to a commercial kitchen, locker room, residential bathrooms.
- E. Material - Pattern Controller and Tees: Aluminum.
- F. Finish - Face and Shell: Baked enamel, black.
- G. Finish - Pattern Controller: Baked enamel, black.
- H. Finish - Tees: Baked enamel, white.
- I. Slot Width: 1 inch
- J. Number of Slots: One, Two, Three or Four
- K. Length: As noted in the Air Device Schedule
- L. Accessories: Plaster frame for drywall or plaster ceilings

2.05 LOUVERS

- A. Louvers shall be extruded aluminum with 12 gauge blades and frames 2" deep up to 12" in height. 4" deep from 12" to 36" in height, and 6" deep above 36" in height. Louvers shall be storm proof design and shall not pull rain through the blades at the capacity required by the system.
- B. Furnish a bird screen on each louver mounted at the inside face.
- C. Frames shall be miter welded with reinforced corners.
- D. Louver finish shall be determined by the architect. Contractor to coordinate.
- E. Manufacturer: American Warming and Ventilating, Ruskin, Greenheck and Pottorff, United Enertech.

2.06 AIR FILTERS

- A. Refer to drawings and schedules for certain air filtration requirements for various systems.
- B. These filters are to be installed in air handling equipment if the equipment is capable of receiving them. If not, the contractor shall install the filters in a filter frame with gasketed doors on the entering side of the unit. The filter frame in either case shall provide an airtight fit with gaskets.
- C. Furnish and install a red oil manometer for each filter of efficiency of 30 percent or more and with a range of 0 to 30 inches water gage. Gauge to be Dwyer Instruments, Inc.
- D. The filter shall meet a minimum of MERV (xx) @ 2000 cfm (500 fpm) per ASHRAE Standard 52.2-2007 and shall be required to meet the same MERV-A value when tested per "Appendix

j" of the aforementioned Standard. A filter with a MERV -A value lower than the MERV rating is not acceptable.

- E. Manufacturers: CAMFIL/FARR Co., ECO Air Filters, Flanders, American Air Filter.

2.07 SOUND TRAPS

- A. Furnish and install prefabricated sound traps of the size and capacity indicated.
- B. Outer casing of 22 gauge galvanized steel, lock formed seams, 26 gauge galvanized steel perforated liners, inorganic mineral, or fiberglass fill.
- C. Manufacturer: I.A.C., SEMCO, BRD Noise & Vibration Control, Inc., Vibro Acoustics or as indicated on drawings.
- D. Contractor to provide three duct diameters on the inlet side of the sound traps.

2.08 DRUM LOUVERS

- A. Furnish and install the drum louvers of the size and capacity indicated on the drawings.
- B. Drum louvers shall be extruded aluminum.
- C. Drum louvers shall have opposed blade damper, adjustable louver vanes, 60° angular adjustment control (30° up and 30° down).
- D. Custom finish is selected by the architect.
- E. Coordinate ductwork opening size with drum louver size.
- F. Manufacturers: Krueger "DPL" Series or prior approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install diffusers level and plumb.
- B. Supports: Galvanized steel per SMACNA.
- C. 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.
- D. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.02 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

3.03 LOUVERS

- A. Louvers shall be set plumb in wall openings left by general contractor.
- B. Coordinate openings with G. C.
- C. Louvers shall be anchored in masonry construction.

- D. Frames shall be caulked watertight. Color of caulking shall be acceptable to the architect.
- E. Connections to wall louvers shall be sloped down to louver connection to prevent water draining into interior.

3.04 FILTERS

- A. All filters shall be clean prior to acceptance by the owner. Renewable media filters shall be replaced with new filters. Cleanable filters shall be removed and cleaned just prior to acceptance.
- B. Provide one spare set of replaceable filters for each system to the owner prior to acceptance of the work.

END OF SECTION

SECTION 23 37 13.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Adjustable blade face registers and grilles.
 - 2. Fixed face registers and grilles.
- B. Related Requirements:
 - 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
 - 2. Section 233713.13 "Air Diffusers" for various types of air diffusers.
 - 3. The SMACNA Low Velocity Duct Manual, ASHRAE Handbooks, International Mechanical Code, and NFPA Pamphlet 90A shall apply to this work.
 - 4. Refer to Section 233113 "Metal Ductwork".

1.02 WORK INCLUDED

- A. Provide labor, material, equipment, and supervision necessary to install a complete air handling system with all supply and return distribution devices as indicated on the drawings and specified herein.
- B. Contractor is to furnish and install a volume damper in all supply, return, exhaust, and outside air branch ductwork. If these are omitted from the drawings, the contractor is to make an allowance to install one.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Submit manufacturer's literature and performance data of equipment and devices for review.
- C. Samples; Furnish at request of A/E.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with manufacturer's warranty requirements.
- B. Provide adequate supervision of labor force to see that installations are correct.

PART 2 - PRODUCTS

2.01 REGISTERS

- A. Furnish and install terminal air registers of the size and capacities indicated on the drawings.
- B. Adjustable Blade Face Register:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Anemostat Products; a Mestek company.
 - b. Carnes Company.
 - c. Krueger.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.
 - f. Price Industries.
 - g. Titus.
 - h. Tuttle & Bailey.
 2. Material: Steel. Shall be aluminum if located in a damp area similar to a commercial kitchen, locker room, residential bathrooms.
 3. Finish: Baked enamel, white.
 4. Face Blade Arrangement: Horizontal, spaced -1/2 inch centers for return and exhaust and 3/4 inch centers for supply, single set at 45 degrees for return or exhaust and double deflection adjustable for supply. Reinforced corners, mitered.
 5. Core Construction: Removable.
 6. Rear-Blade Arrangement: Vertical, spaced 1/2 inch centers for return and exhaust and 3/4 inch centers for supply.
 7. Frame: 1 inch wide.
 8. Mounting Frame: Provide separable frames in drywall, plaster, or masonry construction as noted on the architectural drawings.
 9. Mounting: Countersunk screw
 10. Damper Type: Adjustable opposed blade
- C. Fixed Face Register
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Carnes Company.
 - c. Krueger.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
 2. Material: Steel. Shall be aluminum if located in a damp area similar to a commercial kitchen, locker room, residential bathrooms.
 3. Finish: Baked enamel, white.
 4. Face Blade Arrangement: Horizontal, spaced 1/2 inch centers for return and exhaust and 3/4 inch centers for supply, single set at 45 degrees for return or exhaust and double deflection adjustable for supply. Reinforced corners, mitered.
 5. Face Arrangement: Perforated core.
 6. Core Construction: Removable.
 7. Frame: 1 inch wide.
 8. Mounting Frame: Provide separable frames in drywall, plaster, or masonry construction as noted on the architectural drawings.
 9. Mounting: Countersunk screw
 10. Damper Type: Adjustable opposed blade
 11. Accessory: Filter.
- D. Furnish and install turning vanes for connections to ducts.
- E. Where registers are located low near floor, they shall be heavy duty 14 gauge steel with fixed 45 degree blades on 1/2" centers. In damp areas, they shall be extruded aluminum.
- F. Where drawings indicate linear return grilles, they shall be linear extruded aluminum with 1/8" bars 3/4" long on 1/4" centers.

2.02 GRILLES

- A. Furnish and install terminal air registers of the size and capacities indicated on the drawings.
- B. Adjustable Blade Face Grille:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Carnes Company.
 - c. Krueger.
 - d. METALAIRE, Inc.
 - e. Nailor Industries Inc.
 - f. Price Industries.
 - g. Titus.
 - h. Tuttle & Bailey.
 2. Material: Steel. Shall be aluminum if located in a damp area similar to a commercial kitchen, locker room, residential bathrooms.
 3. Finish: Baked enamel, white.
 4. Face Blade Arrangement: Horizontal spaced 1/2 inch apart.
 5. Core Construction: Removable.
 6. Rear-Blade Arrangement: Horizontal, spaced 1/2 inch centers for return and exhaust and 3/4 inch centers for supply, single set at 45 degrees for return or exhaust and double deflection adjustable for supply. Reinforced corners, mitered.
 7. Frame: 1 inch.
 8. Mounting Frame: Provide separable frames in drywall, plaster, or masonry construction as noted on the architectural drawings.
 9. Mounting: Countersunk screw.
 10. Accessories:
 - a. Filter.
- C. Fixed Face Grille
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anemostat Products; a Mestek company.
 - b. Carnes Company.
 - c. Krueger.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
 2. Material: Steel. Shall be aluminum if located in a damp area similar to a commercial kitchen, locker room, residential bathrooms.
 3. Finish: Baked enamel, white
 4. Face Blade Arrangement: Horizontal, spaced 1/2 inch centers for return and exhaust and 3/4 inch centers for supply, single set at 45 degrees for return or exhaust and double deflection adjustable for supply. Reinforced corners, mitered.
 5. Face Arrangement: Perforated core.
 6. Core Construction: Removable.
 7. Frame: 1 inch
 8. Mounting Frame: Provide separable frames in drywall, plaster, or masonry construction as noted on the architectural drawings.
 9. Mounting: Countersunk screw.

- 10. Accessory: Filter.
- D. Furnish and install turning vanes for connections to ducts.
- E. Where registers are located low near floor, they shall be heavy duty 14 gauge steel with fixed 45 degree blades on 1/2" centers. In damp areas, they shall be extruded aluminum.
- F. Where drawings indicate linear return grilles, they shall be linear extruded aluminum with 1/8" bars 3/4" long on 1/4" centers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Supports: Galvanized steel per SMACNA.
- C. Outlets and Inlets Locations: 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.
- D. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.02 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 37 23 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Roof hoods.

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sustainable Design Submittals:
 - 1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- C. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
- D. Samples: For each exposed product and for each color and texture specified.
- E. Delegated-Design Submittal: For shop-fabricated ventilators 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 shop-fabricated ventilators.

1.04 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For ventilators, accessories, and components, from manufacturer.

1.05 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.01 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. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.
 - 2. Use Phillips flat hex-head or Phillips pan head screws for exposed fasteners unless otherwise indicated.
- E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.02 FABRICATION, GENERAL

- A. Factory fabricate gravity 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.

2.03 ROOF HOODS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme Engineering & Manufacturing Corp.
 - 2. Aerovent; a division of Twin City Fan Companies, Ltd.
 - 3. Carnes Company.
 - 4. Greenheck Fan Corporation.
 - 5. JencoFan.
 - 6. Loren Cook Company.
 - 7. PennBarry.
 - 8. Twin City Fan & Blower.
- B. Factory fabricated according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.
- C. Materials: Aluminum sheet, minimum 0.063-inch- thick base and 0.050-inch-thick hood; suitably reinforced.
- D. Roof Curbs: Aluminum sheet; with mitered and welded corners; 1 ½ -inch- thick, rigid fiberglass insulation adhered to inside walls; and 1 ½ -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: Minimum 12".
- E. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire or Flattened, expanded aluminum, 3/4 by 0.050 inch thick or Stainless-steel, 1/2-inch- square mesh, 0.047-inch wire.
- F. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch or Stainless-steel, 18-by-18- mesh, 0.009-inch wire.
- G. 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.
 3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Secure gravity ventilators to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible. Refer to Section 077200 "Roof Accessories."
- C. Install gravity ventilators with clearances for service and maintenance.
- D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.
- F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- G. 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.
- H. 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.

END OF SECTION

SECTION 23 72 00 - AIR TO AIR ENERGY RECOVERY UNIT

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to section 23 05 00 for requirements which are applicable to this section.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to furnish, install, and place into operation recovery units as specified in this section.
- B. Control wiring shall be furnished under this portion of the work.

1.03 SUBMITTALS

- A. Submit shop drawings of equipment from manufacturers.
- B. Submit manufacturers' data sheets of performance capability.
- C. Submit design data for units.
- D. Submit wiring diagrams of controls.
- E. Product data: For each type or model of Energy Recovery Ventilator, include the following:
 - 1. Unit performance data for both Supply Air and Exhaust Air, with system operating conditions indicated.
 - 2. Enthalpy plate performance data for both summer and winter operation.
 - 3. Motor ratings and unit electrical characteristics.
 - 4. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 - 5. Estimated gross weight of each installed unit.
 - 6. Filter types, quantities, and sizes
 - 7. Installation, Operating and Maintenance manual (IOM) for each model.
- F. For air-to-air energy recovery ventilators, 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.
- G. Operation and maintenance data for air-to-air energy recovery ventilator

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.
- B. The ERV core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten (10) years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two (2) years from the date of installation.
- C. Manufacturer shall be able to provide evidence of independent testing of the core by Underwriters Laboratory (UL), verifying a maximum flame spread index (FSI) of 25 and a

maximum smoke developed index (SDI) of 50 thereby meeting NFPA90A and NFPA 90B requirements for materials in a compartment handling air intended for circulation through a duct system. The method of test shall be UL Standard 723.

D. Certifications:

1. The energy recovery cores used in these products shall be third party Certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. AHRI published certifications shall confirm manufacturer's published performance for airflow, static pressure, temperature and total effectiveness, purge air (OACF) and exhaust air leakage (EATR). Products that are not currently AHRI certified will not be accepted. OACF shall be no more than 1.02 and EATR shall be at 0% against balanced airflow.
2. Entire unit shall be listed under UL 1812 Standard for Ducted Air to Air Heat Exchangers and comply with CSA Standard 22.2.

E. Every unit to be factory tested prior to shipping: Motor Dielectric Voltage-Withstand Bench Test, Unit Dielectric Voltage-Withstand Test, Continuity of Internal Control Circuits Test, Unit Amperage Test

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: RenewAire or prior approved equal.
- B. Manufacturer should be in business for minimum 10 years manufacturing energy recovery ventilators.

2.02 MANUFACTURED UNITS

- A. Air-to-Air Energy Recovery Ventilators shall be fully assembled at the factory and consist of a fixed-plate cross-flow heat exchanger with no moving parts, an insulated single wall G90 galvanized 20-gauge steel cabinet, motorized outside air intake damper, filter assemblies for both intake and exhaust air, enthalpy core, supply air blower assembly, motorized return air damper, exhaust air blower assembly and electrical control box with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection. Entire unit with the exception of field-installed components shall be assembled and test operated at the factory.

2.03 CABINET

- A. Materials: Formed single wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
- B. Outside casing: 20 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish.
- C. Access doors shall be hinged with airtight closed cell foam gaskets. Door pressure taps, with captive plugs, shall be provided for cross-core pressure measurement allowing for accurate airflow measurement.
- D. Unit shall have factory-installed duct flanges on all duct openings.
- E. Cabinet Insulation: Unit walls and doors shall be insulated with 1 inch, 4 pound density, foil/scrim faced, high density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with a minimum R-value of 4.3 (hr-ft²-F/BTU).

- F. Enthalpy core: Energy recovery core shall be of the total enthalpy type, capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air. No condensate drains shall be allowed. The energy recovery core shall be designed and constructed to permit cleaning and removal for servicing. The energy recovery core shall have a ten year warranty. Performance criteria are to be as specified in AHRI Standard 1060.
- G. Control center / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections to the non-fused disconnect.
- H. Passive Frost Control: The ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -10 F and inside relative humidity below 40%). Occasional more extreme conditions shall not affect the usual function, performance, or durability of the core. No condensate drains will be allowed.
- I. Motorized isolation dampers: Return and outside air motorized dampers of an AMCA Class I low leakage type shall be factory installed.

2.04 BLOWER SECTION

- A. Blower section construction, Supply Air and Exhaust Air: Blower assemblies consist of a ODP motor, and a direct driven forward-curved blower (Refer to schedule for voltage and phase).
- B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

2.05 MOTORS

- A. Blower motors shall be Premium Efficiency, EISA compliant for energy efficiency. The blower motors shall be totally enclosed (TEFC) and shall be supplied with factory installed motor starters. Direct drive models (EV450 and HE1X models) shall be EISA-compliant for energy efficiency with open drip proof design and integral thermal protection.

2.06 UNIT CONTROLS

- A. Fan control: Dual contactors for independent blower control.
- B. Timeclock: Digital Time Clock wall mount, with up to 8 on/off cycles per day or 50 per week, 24VAC power, with battery backup protection of program settings against power failure to energize unit.
- C. Motion (Occupancy) Sensor: Passive infrared sensor for ceiling mounting with adjustable time-off delay to 30 minutes, 24VAC power to energize unit.
- D. Carbon Dioxide: Adjustable control from 600 - 2000 PPM for wall mounting with digital display.
- E. Factory-installed microprocessor controller and sensors, Premium ERV controls that:
 - 1. Comply with requirements in Division 23 Section "Sequence of Operations for HVAC Controls".
 - 2. Has factory-installed hardware and software to enable the building automation interface via BACnet to monitor, control, and display status and alarms.
 - 3. The microprocessor controller shall be capable of operating at temperatures between -20F to 160F.

4. The microprocessor controller shall be a DIN rail mounting type.
5. Factory-installed microprocessor controller shall come with backlit display that allows menu-driven display for navigation and control of unit.
6. The microprocessor controller shall have the ability to communicate with the BMS via Modbus RTU/TCP and BACnet MSTP/IP
7. The microprocessor controller shall have integrated ethernet interface and a web server for displaying unit parameters.
8. The microprocessor shall have near field communication (NFC) capability for android devices.
9. The microprocessor controller shall have an internal programmable time clock that will allow the user to add up to different occupancy schedules and add holidays.
10. The microprocessor control shall be capable of integral diagnostics.
11. The microprocessor control shall be capable of IP or SI unit display.
12. The microprocessor controller shall have a battery powered clock.
13. The microprocessor controller shall at a minimum offer the ability for three modes of determining occupancy: a dry contact, the internal time clock or the BMS.
14. A remote user terminal to allow for remote monitoring and adjustment of parameters, allowing ease of control access without going outdoors or into the mechanical room if desired by the user.
15. The microprocessor controller shall have at a minimum (10) universal inputs/outputs (AI, DI, AO) and have (6) six relay outputs (DO)
16. The microprocessor controller shall have an Integrated fieldbus port.
17. The microprocessor controller shall have the capability for I/O expansion
18. The microprocessor controller shall have a micro USB port to load the application program, the unit parameters, saving logs, etc.
19. The sensors that will be required for control are:
 - a. (2) Temperature sensors for fresh air and exhaust air
 - b. (2) Temperature and humidity sensors for outside air, return air
 - c. (2) Differential pressure sensors for filter alarms
 - d. (2) Differential pressure sensors for measuring pressure drop across energy recovery core and for determining airflow in both airstreams
 - e. (2) Adjustable current switches
20. The microprocessor controller shall have the capability to monitor the unit conditions for alarm conditions. Upon detecting an alarm, the microprocessor controller shall have the capability to record the alarm description, time, date, available temperatures, and unit status for user review. A digital output shall be reserved for remote alarm indication. Alarms to be also communicated via BMS as applicable. Provide the following alarm functions:
 - a. Outside air temperature sensor alarm
 - b. Outside air humidity sensor alarm
 - c. Return air temperature sensor alarm
 - d. Return air humidity sensor alarm
 - e. Fresh air sensor alarm
 - f. Exhaust air sensor alarm
 - g. Dirty filter alarm
 - h. Supply and exhaust air proving alarm
 - i. Airflow out of range alarm
21. Display the following on the face of microprocessor controller:
 - a. Unit on
 - b. Outdoor air temperature
 - c. Outdoor air humidity

- d. Return air temperature
 - e. Return air humidity
 - f. Supply air temperature
 - g. Airflows in both airstreams
 - h. Unit on/off
 - i. Fan on/off
 - j. Damper status
 - k. Alarm digital display
22. The microprocessor controller shall have factory pre-programmed multiple operating sequences for control of the ERV. Factory default settings shall be fully adjustable in the field.

2.07 SEQUENCE OF OPERATIONS

A. DDC CONTROLLER:

- 1. Controller with integral LCD readout for changing set points and monitoring unit operation.
- 2. Provided with required sensors and programming.
- 3. Factory programmed, mounted, and tested.
- 4. Integral USB and Ethernet ports for updating programs and retrieving log files.

B. GENERAL OPERATION

C. POWER UP:

- 1. When the unit main disconnect is closed a delay of 10 seconds (adjustable) occurs for the controller to come online.

D. ERV UNIT START COMMAND:

- 1. An input signal is required to enable the unit operation. The unit will be commanded on by:
 - a. Enable via controller display.
- 2. All types of input that are enabled must be true before the unit will start.
 - a. The exhaust fan starts after a 3 second delay (adjustable). The exhaust fan will not start until the damper actuator end switch closes.
 - b. The supply fan starts after a 6 second delay (adjustable). The supply fan will not start until the damper actuator end switch closes.
 - c. The supply fan, exhaust fan is controlled based on the chosen unit operating modes and air conditions.

E. ERV UNIT STOP COMMAND (OR DE-ENERGIZED):

- 1. The unit can then be commanded off by:
 - a. Disable via controller display.
- 2. Supply fan and exhaust fan are de-energized.
- 3. All dampers are unpowered and spring return to their default position after a 10 second delay (adjustable).

F. SUPPLY FAN OPERATION:

- 1. The supply fan will operate at a constant speed.
- 2. The unit will attempt to start the supply fan when the supply fan delay timer expires. When the supply fan starts the supply fan adjustable current switch should close and remain closed until the fan is turned off.

G. SUPPLY FAN STATUS:

After a delay of 90 seconds (adjustable) from supply fan start signal, if the supply fan current switch is still open the supply fan alarm should be set to true. The supply fan status shall be set to true only when the supply fan output is on and supply fan current switch is closed. The supply fan status shall be false in all other circumstances.

H. EXHAUST FAN OPERATION:

1. The exhaust fan will operate at a constant speed.
2. The unit will attempt to start the exhaust fan when the exhaust fan delay timer expires. When the exhaust fan starts the exhaust fan adjustable current switch should close and remain closed until the fan is turned off.

I. EXHAUST FAN STATUS:

1. After a delay of 90 seconds (adjustable) from exhaust fan start signal, if exhaust fan current switch is still open the exhaust fan alarm should be set to true. The exhaust fan status shall be set to true only when the exhaust fan output is on and exhaust fan current switch is closed. The exhaust fan status shall be false in all other circumstances.
2. Integrate ERU controls with associated electric duct heater controls. Furnish and install air proving switch.

2.08 FILTER SECTION

- A. ERV shall have 2" thick MERV 13 disposable pleated filters located in the outdoor air and exhaust airstreams. All filters shall be accessible from the exterior of the unit.

PART 3 - EXECUTION

3.01 ENERGY RECOVERY UNIT

- A. Coordinate location with other trades.
- B. Furnish and install equipment from structure above. Support unit in accordance with the manufacturer's instructions.
- C. Protect and be responsible for equipment until accepted in place by the owner.
- D. Units shall be arranged for either horizontal discharge or vertical down discharge as indicated on the drawings.
- E. Contractor to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage.
- F. Contractor to train owner's maintenance personnel to adjust, operate and maintain the entire ERV unit.

3.02 GENERAL

- A. Any equipment mars, blemishes, scratches, abrasions, or other surface imperfections shall be sanded, primed, and refinished to match adjacent surfaces.
- B. No equipment will be accepted by the owner which has rust, corrosion, or otherwise in progress.
- C. Equipment shall not be used for temporary heat unless separately negotiated with the owner.
- D. All filters shall be new at time of acceptance by the owner.
- E. All bare ferrous metal shall be painted prior to acceptance.
- F. Equipment shall be in perfect working order prior to acceptance.

END OF SECTION

SECTION 23 74 16.15 - PACKAGED, LARGE-CAPACITY, GAS FIRED ROOFTOP UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes packaged, large-capacity, rooftop air conditioning units (RTUs) with the following components and accessories:
 - 1. Casings.
 - 2. Fans.
 - 3. Motors.
 - 4. Coils.
 - 5. Refrigerant circuit components.
 - 6. Air filtration.
 - 7. Supported bag filters.
 - 8. Gas furnaces.
 - 9. Dampers.
 - 10. Electrical power connections.
 - 11. Controls.
 - 12. Accessories
 - 13. Roof curbs.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.
 - 3. Product Data: For energy performance.
 - 4. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 - 5. Product Data: For air filtration performance.
- C. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.
- B. Field quality-control reports.
- C. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of RTUs 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 Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
 4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. AHRI Compliance:
1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
 2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
 3. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
- B. AMCA Compliance:
1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
 2. Damper leakage tested in accordance with AMCA 500-D.
 3. Operating Limits: Classify according to AMCA 99.
- C. ASHRAE Compliance:
1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. NFPA Compliance: Comply with NFPA 90A or NFPA 90B.
- F. UL Compliance: Comply with UL 1995.
- G. 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.

2.02 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daikin Applied.
 2. Lennox Industries, Inc.; Lennox International.
 3. Trane – Voyager III.
 4. YORK; a Johnson Controls company.

2.03 CAPACITIES AND CHARACTERISTICS

- A. Refer to drawings for performance requirements.

2.04 CASINGS

- A. General Fabrication Requirements for Casings: Formed and reinforced insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Single Wall Construction.
- C. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 1. Corrosion Protection: 671 hours salt spray test in accordance with ASTM B117.
- D. Inner Casing Fabrication Requirements:
 - 1. Inside Casing: G-90-coated galvanized steel, 0.028 inch thick.
- E. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1. Materials: ASTM C 1071, Type I.
 - 2. Thickness: 1/2 inch.
 - 3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 - 4. Liner Adhesive: Comply with ASTM C 916, Type I.
- F. Condensate Drain Pans: Fabricated using G-90-coated galvanized 0.028 inches thick sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1 for design and construction of drain pans.
 - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 - 2. Drain Connections: Threaded nipple.
- G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.05 FANS

- A. Supply-Air Fans:
 - 1. Belt-Driven Supply-Air Fans: Motors shall be installed on an adjustable fan base resiliently mounted in the casing.
- B. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated motors.
- C. Relief-Air Fan: Propeller Forward curved Backward inclined, shaft mounted on permanently lubricated motor.

2.06 MOTORS

- A. Comply with NEMA MG 1, Design B, medium induction motor, unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.
- C. 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.
- D. Duty: Continuous duty at ambient temperature of 104 deg. F and at altitude of 3300 feet above sea level.

- E. 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.
- F. Efficiency: Energy efficient, as defined in NEMA MG 1.
- G. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements.
- H. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- I. Multispeed Motors: Separate winding for each speed.
- J. Rotor: Random-wound, squirrel cage.
- K. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- L. Temperature Rise: Match insulation rating.
- M. Insulation: Class F.
- N. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- O. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- P. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. 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.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.07 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
 - 3. Coil Split: Interlaced.
 - 4. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections.
- B. Outdoor-Air Refrigerant Coil:
 - 1. Aluminum plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
 - 3. Provide Corrosion Protected Condenser Coil Option that shall include an all aluminum microchannel condenser coil protection shall consist of a corrosion resistant coating that shall withstand ASTM B117 Salt Spray test for 6,000 hours and ASTM G85 A2 Cyclic Acidified Salt Fog test for 2,400 hours. This coating shall be added after coil construction covering all tubes, headers, and fin edges, therefore providing optimum protection in more corrosive environments.

2.08 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: Two.
- B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- C. Refrigeration Specialties:
 - 1. Refrigerant: R-410A.
 - 2. Expansion valve with replaceable thermostatic element.
 - 3. Refrigerant filter/dryer.
 - 4. Manual-reset high-pressure safety switch.
 - 5. Automatic-reset low-pressure safety switch.
 - 6. Minimum off-time relay.
 - 7. Automatic-reset compressor motor thermal overload.
 - 8. Brass service valves installed in compressor suction, liquid lines and discharge 3-way shutoff valves.
 - 9. Units shall have cooling capabilities down to 0 degree F as standard. For field-installed low ambient accessory, the manufacturer shall provide a factory-authorized service technician that will assure proper installation and operation.

2.09 AIR FILTRATION

- A. Minimum arrestance and MERV according to ASHRAE 52.2 2007 and shall be required to meet the same MERV-A value when tested per "Appendix j" of the aforementioned Standard. A filter with a MERV -A value lower than the MERV rating is not acceptable.

2.10 GAS FURNACES

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
 - 1. Fuel: Natural gas.
 - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
 - 3. Modulating Gas Heaters shall be made from grades of stainless steel suitable for condensing situations. The heater shall have a turn down ratio of 2.5 to 1 for low heat and 5 to 1 for high heat.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Venting: Gravity vented with vertical extension.
- E. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.
- F. Safety Controls:
 - 1. Gas Control Valve: Two stage Modulating.
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.11 DAMPERS

- A. Outdoor- and Return-Air Mixing Dampers: Opposed blade galvanized-steel dampers

mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage or gears and interconnect so dampers operate simultaneously.

1. Leakage Rate: As required by ASHRAE/IES 90.1.
2. Damper Motor: Modulating with adjustable minimum position.
3. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IES 90.1, with bird screen and hood.

2.12 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.13 CONTROLS

- A. DDC Controller:
1. Control equipment and sequence of operation are specified in Section 230933 "Building Automation System." "Automatic Temperature Control"
- Basic Unit Controls:
2. Control-voltage transformer.
 3. Wall-mounted thermostat with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
- B. DDC Controller:
1. Controller shall have volatile-memory backup.
 2. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire-alarm control panel.
 - b. Fire-Alarm Control Panel Interface: Provide control interface to the fire alarm system.
 3. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of two programmable periods per day.
 4. Refer to the control specification section for the sequence of operation.
- C. Interface Requirements for HVAC Instrumentation and Control System:
1. Interface relay for scheduled operation.
 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
 3. Provide BACnet compatible interface for central HVAC control workstation for the following:
 - a. Adjusting set points.
 - b. Monitoring supply fan start, stop, and operation.
 - c. Inquiring data to include [outdoor-air damper position,] supply- and room-air temperature [and humidity].
 - d. Monitoring occupied and unoccupied operations.
 - e. Monitoring constant and variable motor loads.

- f. Monitoring variable-frequency drive operation.
- g. Monitoring cooling load.
- h. Monitoring economizer cycles.
- i. Monitoring air-distribution static pressure and ventilation air volume.

2.14 ACCESSORIES

- A. Electric heater with integral thermostat maintains minimum 50 deg. F temperature in gas burner compartment.
- B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- D. Remote potentiometer to adjust minimum economizer damper position.
- E. Return-air bypass damper.
- F. Factory- or field-installed demand-controlled ventilation.
- G. Safeties:
 - 1. Smoke detector - Smoke detector shall be factory installed photoelectric smoke detector mounted in the return air section and/or supply air fan compartment.
 - 2. Condensate overflow switch.
 - 3. Phase-loss protection.
 - 4. High and low pressure control.
 - 5. Gas furnace airflow-proving switch.
- H. Hail guards of galvanized steel, painted to match casing.
- I. Door switches to disable heating or reset setpoint when open.
- J. Outdoor air intake weather hood.
- K. Provide a fully integrated 100% modulating outside air economizer with unit return and barometric relief air dampers, minimum position setting, preset linkage, wiring harness with plug. Unit operation is through primary temperature controls that automatically modulate dampers to maintain space temperature conditions. Economizer shall be dual enthalpy control.
- L. Economizer Power Exhaust
 - 1. Factory supplied, field installed power exhaust assembly.
 - 2. Modulating 100% Exhaust Fan with Control Option shall include a differential pressure control system, the controller shall use a differential pressure transducer to compare indoor building pressure to outdoor ambient atmospheric pressure and shall turn the exhaust fans on and off and modulate the barometric exhaust dampers to control the building pressure to within the adjustable, specified dead band that shall be adjustable at the RTVM board
- M. Dehumidification / Hot Gas Reheat - Unit shall be equipped with internally finned, 5/16" copper tubes. The coil shall be 2 rows with a minimum of 16 fins per inch. Dehumidification shall be achieved by routing hot refrigerant gas from the discharge line of the compressor through the reheat coil.
- N. Delivered VAV
 - 1. Unit shall be provided with VFD (Variable Frequency Drive) on Indoor fan motor. VFD shall change fan speed according to mode of operation. The VFD shall receive a 0-10 Vdc signal from the unit controls based upon supply static pressure and shall cause the drive to accelerate or decelerate as required to maintain the supply static pressure setpoint. When subjected to high ambient return conditions the VFD shall reduce its output frequency to maintain operation.
 - 2. Unit shall be provided with shaft grounding rings for electrical protection. Shaft

grounding rings provide long term motor/VFD bearing reliability.

- O. Provide a Human Interface that shall have a 5 inch color touchscreen display that conforms to FCC Part 15 Class B with an Ingress Protection Rating of IP24. The display text shall be readable by a person with 20/20 vision at a distance of 3 feet and 60° angle at lighting levels ranging from 100 lux - 25,000 lux. Also, the display shall operate at temperatures of -40°C to 70°C. Firmware and unit configurations shall be able to be restored via a USB storage device.

2.15 ROOF CURBS

- A. Roof curbs with vibration isolators are specified in Section 230548 "Vibration Controls for HVAC."
- B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
- C. Curb Dimensions: Height of 48 inches.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Roof Curb: Install on roof structure, level and secure, according to the roofing manufacturers requirements. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in the architectural specifications. Secure RTUs to upper curb rail, and secure curb base to roof framing with anchor bolts.
- B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
- C. Any equipment mars, blemishes, scratches, abrasions, or other surface imperfections shall be sanded, primed, and refinished to match adjacent surfaces.
- D. No equipment will be accepted by the owner which has rust, corrosion, or otherwise in progress.
- E. Equipment shall not be used for temporary heat unless separately negotiated with the owner.
- F. All filters shall be new at time of acceptance by the owner.
- G. All bare ferrous metal shall be painted prior to acceptance.
- H. Equipment shall be in perfect working order prior to acceptance.
- I. Furnish and install all controls and control wiring. Wiring shall be in accordance with the NEC. Control wiring above the roof shall be in galvanized steel conduit with watertight fittings.

3.02 CONNECTIONS

- A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- B. Install piping adjacent to RTUs to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination at top of roof curb.

2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.03 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. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 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. RTU will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.04 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION

SECTION 23 81 27 - DUCTLESS SPLIT SYSTEM

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 23 05 00 for requirements which are applicable to this section.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to furnish, install, and place into operation ductless split systems as specified herein.
- B. Power wiring will be provided under the Electrical portion of the work.
- C. Control wiring shall be furnished under this portion of the work.
- D. Furnish ductless split system heat pumps or air conditioning units of the quantity, size and capacity shown on the equipment schedules.
- E. System shall be a complete factory package consisting of compressor, evaporator coil, fan and motor, condenser coil fan and motor and complete refrigeration and heat pump temperature controls, and interconnecting wiring and refrigerant piping.
- F. Unit shall be rated in accordance with latest version ARI Standard 380 and shall be U.L. listed.

1.03 SUBMITTALS

- A. Submit shop drawings of all equipment.
- B. Submit manufacturers' data sheets of capacity.
- C. Submit wiring diagrams of control system.
- D. Submit piping diagrams of refrigeration interconnection.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.

PART 2 - PRODUCTS

2.01 INDOOR UNIT

- A. The unit shall have a self-diagnostic function, 3-minute time delay mechanism.
- B. Factory pre-charge of R454B adequate for 33 feet of total length.
- C. The indoor units shall have a white, "flat screen" finish.
- D. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.
- E. The cabinet includes an "intelligent-eye" motion sensor capable of setting back the set point temperature for energy savings. This feature may be disengaged on the wire remote controller.

- F. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor. The fan shall be statically and dynamically balance and operate on a motor with permanent lubricated bearings.
- G. The return air filter provided will be a removable and washable filter.
- H. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger with factory pressure tested.

2.02 OUTDOOR UNIT

- A. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls.
- B. The cabinet shall be Ivory White with a finished powder coated backed enamel paint.
- C. The fan shall be a direct drive, propeller type fan.
- D. The motor shall be inverter drive, permanently lubricated type bearings, inherent.
- E. The fan shall be capable of operating in "silent operation" which lowers the outdoor fan speed in either cool, heat or auto modes.
- F. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
- G. The outdoor coil shall be nonferrous construction with corrugated fin tube.
- H. The compressor shall be a rotary swing inverter-driven compressor.
- I. The outdoor unit shall have an accumulator, four-way reversing valve.
- J. The compressor shall have an internal thermal overload.
- K. The outdoor unit can operate with a maximum vertical height difference of 49 feet and overall maximum length of 66 feet without any oil traps, liquid or suction line changes.

2.03 REMOTE CONTROLLER

- A. Microprocessor technology with remote controller with LCD display.
- B. Operation Mode Setting (Heat, Auto, Cool/Dry).
- C. Temperature setting (in units of two degrees Fahrenheit)
- D. Self-Diagnostic Display.
- E. Room Temperature Display.
- F. Twenty-Four Hour On/Off Timer.
- G. Fan Speed Indicator.
- H. Auto/Speed Vane Operation
- I. Memory (for storing operation functions)
- J. Low Ambient Operation
- K. Whisper-Quiet Operation
- L. EMS Gateway Available to Management System via RS-232 Cable.

2.04 MANUFACTURERS

- A. Manufacturer: Daikin, Mitsubishi, LG.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install units in accordance with manufacturer's instructions.
- B. Mount compressors on Neoprene pads on roof curbs.
- C. Mount indoor unit on concealed blocking for additional support.
- D. Install pre-charged refrigerant lines through manufactured roof curbs by Pate or equal.
Maintain watertight integrity of penetration.

END OF SECTION

SECTION 23 81 27 - SPLIT-SYSTEM HEAT PUMP

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: 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.

1.03 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 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 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.06 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:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation.
 2. Daikin
 3. Lennox Industries, Inc.
 4. Trane.
 5. YORK; a Johnson Controls company.

2.02 INDOOR UNITS (5 TONS OR LESS)

- A. Concealed Evaporator-Fan Components:
1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 2. Insulation: Faced, glass-fiber duct liner.
 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 4. 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.
 5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
 6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
 7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 8. Filters: Permanent, cleanable.
 9. Condensate Drain Pans:
 - a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2 inches deep.
 - b. Single-wall, galvanized-steel sheet.
 - c. 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 1.5-inch
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
 10. Condensate overflow switch

11. Low leakage Cabinet (Qleak) less than 2%.

2.03 OUTDOOR UNITS -5 TONS OR LESS

- A. Air-Cooled, Compressor-Condenser Components:
 1. 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.
 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
 4. Fan: Aluminum-propeller type, directly connected to motor.
 5. Motor: Permanently lubricated, with integral thermal-overload protection.
 6. Low Ambient Kit

2.04 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230933 Automatic Temperature Control or 230933 Building Automation System
- B. Solid-State Thermostat: Wall-mounted programmable, microprocessor-based unit with automatic switching from heating to cooling, preferential rate control, seven-day programmability with minimum of four temperature presets per day, vacation mode, and battery backup protection against power failure for program settings. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits For 5 Tons and Under: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- D. Drain Hose: For condensate.

PART 3 - EXECUTION

3.01 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 roof-mounted, compressor-condenser components on equipment support curbs.
- D. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). The base shall be a minimum of 4" thick and set on 6"s of crushed stone.
 2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
 3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Coordinate the electrical requirements of the unit with the electrical contractor prior to ordering or installing the equipment.
- F. Furnish and install all controls and control wiring. Wiring shall be in accordance with the NEC. Control wiring above the roof shall be in galvanized steel conduit with watertight fittings.
- G. Installations shall be in accordance with the instructions of the manufacturer and meet all requirements.
- H. Protect and be responsible for equipment until accepted in place by the owner.
- I. Provide condensate drain and discharge to a suitable discharge point which shall be acceptable to the owner and A/E.
- J. Contractor shall interlock the air handling unit controls with the remote condensing unit and electric resistance heaters. Contractor is to furnish and install an air proving switch or current sensor at the air handler's blower and be interlocked with the associated condensing unit and electric resistance heater controls to shut down if power to the blower is disconnected.
- K. All filters shall be new at time of acceptance by the owner.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 233113 "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 Section 233300 "Air Duct Accessories."

3.03 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. 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.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.
- E. Any equipment mars, blemishes, scratches, abrasions, or other surface imperfections shall be sanded, primed, and refinished to match adjacent surfaces.
- F. No equipment will be accepted by the owner which has rust, corrosion, or otherwise in

- progress.
- G. Equipment shall not be used for temporary heat unless separately negotiated with the owner.
 - H. All bare ferrous metal shall be painted prior to acceptance.

3.04 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 23 82 30 - CONVECTORS, EXTENDED FIN RADIATION, UNIT HEATERS

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to section 23 05 00 for requirements which are applicable to this section.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to install and place into service the convectors, radiators, and unit heaters described in these specifications.

1.03 SUBMITTALS

- A. Submit shop drawings of all equipment.
- B. Submit manufacturers' data sheets of equipment capacity.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.
- B. Install systems and equipment in accordance with the IBC 2003 Code and the National Electrical Code.

PART 2 - PRODUCTS

2.01 BASEBOARD EXTENDED FIN RADIATION

- A. Size and capacity as indicated on drawings.
- B. 3/4" copper tube 2 1/8" X 2 5/16" .007" aluminum elements, 51 FPF.
- C. Enclosure with baked enamel finish, damper assembly, front panel, element guide.
- D. Complete with inside and outside corners, front splices, end caps and end pieces.
- E. 600 BTU per foot at 180 deg. 4 GPM.
- F. Weil McLain Model 75WLT-3 ThermaTrim Baseboard.

2.02 CONVECTORS

- A. Furnish and install convectors of the size and capacity indicated on the drawings. Convectors shall be recessed, semi-recessed, wall, or floor mounted as indicated. Cabinets shall be 16 gauge steel front and top with 20 gauge steel enclosures. Cabinets shall be phosphatized and painted inside and out with one coat of combination light beige prime finish baked on. A baked enamel finish in a color selected by the Architect from manufacturer's color chart shall be provided.
- B. Recessed and semi-recessed models shall be provided with a matching steel wall frame

which shall overlap the opening edges and remain permanently in place. The cabinet front shall fit into a gasketed recess to form a flush front cabinet line on recessed models. Front panels shall be fastened with tamper proof Allen head machine screws.

- C. Access panels shall be provided for access to control and shut off valves.
- D. Convectors fed from below shall be provided with a brass air chamber vent assembly.
- E. Heating elements shall be 1/2 inch round seamless copper tubes with aluminum fins and 1 inch seamless copper headers. Tubes shall be mechanically expanded into fin spacing collars and silver solder brazed to the headers. Header tapping's shall be 3/4 inch FPT. Heating elements shall be tested at 320 PSI hydrostatic pressure.
- F. Convectors shall have inlet and outlet grilles die formed with directional louvers.

2.03 EXTENDED FIN RADIATION

- A. Furnish and install extended fin radiation of the size and capacity indicated on the drawings.
- B. Units shall be wall mounted with 20 gauge steel back plate extending the full height of the enclosure.
- C. Elements shall be copper tube mechanically expanded into .018" thick aluminum fins.
- D. Enclosures shall be 16 gauge steel.
- E. Provide end caps, outside corners, inside corners, and end enclosure with access door.
- F. Slope top units shall have expanded steel discharge grille.
- G. Units shall have extruded aluminum top grilles.
- H. Manufacturers; Airtherm, Vulcan, Slant-Fin, Trane, Standard Fin Pipe.

2.04 UNIT HEATERS - CABINET TYPE

- A. Wall mounted, recessed, or semi-recessed as indicated on the drawings.
- B. Seamless copper tube elements, filters and filter rack, direct drive fans, double extended shaft. Fan and motor mounted on a single motor board, die formed fan housing.
- C. Front panels removable, acoustically insulated, access door to motor, end piping compartment, 16 gauge cabinets, inlet grille in base, and 2 way adjustable discharge grille.
- D. Manufacturers; Airtherm, Vulcan, Slant-Fin, Trane.

2.05 UNIT HEATERS - PROPELLER TYPE

- A. Wall mounted or ceiling mounted propeller type as indicated on the drawings.
- B. Seamless copper tube elements with plate fins, direct drive fan, permanently lubricated split capacitor motor.
- C. Manufacturers; Airtherm, Vulcan, Slant-Fin, Trane.
- D. Casings phosphatized and painted with baked enamel.
- E. Horizontal and vertical adjustable louvers.

2.06 FLOOR RECESSED EXTENDED FIN.

- A. Floor recess formed by others.
- B. Install heating element, bracket, baffles and supports along with all necessary pipe, valves and fittings.
- C. Continuous baffle 20 gauge steel.
- D. 16" x 1 1/2" brackets at maximum 4'-0" on center.
- E. Capacity as scheduled on the drawings.
- F. Furnish and install top extended aluminum bar grille to span opening. Provide steel angle

iron recessed frame.

- G. Paint brackets, baffles, elements and piping flat black. Paint inside of trench flat black.
- H. Manufacturer: Vulcan, Sterling, or approved equal.

2.07 PERIMETER RADIATION - FIELD BUILT ENCLOSURES

- A. Furnish and install wall mounted extended fin radiation complete with valves, fittings, brackets and supports.
- B. Element and tube size as indicated on the drawings.
- C. Copper tube, aluminum fin elements tested at 300 psi.
- D. Extruded aluminum discharge grille with .162" bars on 1/2" centers. 67% free area cross bars on 6" centers. Vulcan type VA or equal.
- E. Enclosure fabricated as detailed on the architectural drawings.

2.08 PEDESTAL RADIATION

- A. Single width units shall be 6 1/4" wide, double width shall be 11 3/16" wide by 5 1/4" high with 3 7/8" pedestals, 18 gauge front and back panels.
- B. Units shall have extruded top grille.
- C. Units shall have copper tube, aluminum fin coils of the size and capacity indicated on the drawing.
- D. Units shall be available in a choice of 8 baked enamel colors.
- E. Units shall be Trane Type E3A.

PART 3 - EXECUTION

3.01 CONVECTORS, RADIATION, AND UNIT HEATERS

- A. Provide rough opening information to the General Contractor to allow for proper wall openings during construction.
- B. Field measure each existing recessed opening for the actual dimension of the required convector. Provide a shop drawing indicating the room number of each space, the opening size, and the type of convector to be provided in the recess. Indicate as to whether the convector is to be recessed, semi-recessed, wall, or floor mounted, and the heating capacity and conditions of performance.
- C. Provide a color chart for selection of color by the Architect.
- D. Install the convector or unit heater with 1 inch rigid fiberglass insulation behind and around the convector where placed in outside walls.
- E. Piping to all elements shall be provided with unions, an automatic control valve on the return side, flow measuring device set to the GPM quantity indicated in the schedule, and shut off valves for servicing.
- F. Provide a mockup of the first unit for review and acceptance by the A/E prior to installation of remaining units. This shall also be reviewed by the owner's representatives prior to further installations.

END OF SECTION

SECTION 23 83 33 - ELECTRIC HEATERS

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 23 05 00 for requirements which are applicable to this section.
- B. Refer to International, NFPA, NEC, and UL requirements for standards relating to these specifications.

1.02 WORK INCLUDED

- A. Provide labor, material, equipment, and supervision necessary to install and place into operation all of the equipment specified in this section.

1.03 SUBMITTALS

- A. Submit manufacturers shop drawings and catalog data sheets of all items in this section.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's instructions.
- B. Provide benchmark construction for review of the owner and architect prior to installation of remaining units. Benchmark unit shall, after review and approval, become the standard against which all other units will be matched.

PART 2 - PRODUCTS

2.01 ELECTRIC BASEBOARD

- A. U.L. Listed, 250 watt per foot density, full length curtain guard, continuous rug guard, 18 gauge steel front cover.
- B. Automatic linear cutout over entire length of heat element.
- C. Continuous raceway, either end connection junction box, aluminum finned metal sheath heating element.
- D. Remote wall mounted thermostat wired by this contractor.
- E. Inside and outside corners as required for installation.
- F. Manufactured by Berko, Markel, QMark or preapproved equal

2.02 WALL MOUNTED ELECTRIC HEATERS

- A. Unit to be UL listed, 16 gauge front panel, baked enamel finish, fully enclosed fan motor permanently lubricated, with integral thermostat.
- B. Units to be by QMark, Markel, Berko or preapproved equal

2.03 CABINET UNIT HEATERS

- A. Unit to be UL listed, cold rolled steel enclosure with baked enamel finish, direct drive blower and motor, 2 speed, overheat protection, integral thermostat, and cleanable filters.
- B. Manufactured by QMark, Markel, Berko or preapproved equal

2.04 WALL MOUNTED AND PEDESTAL HEATERS

- A. Unit to be U.L. listed and of the size and capacity indicated on the drawings.
- B. Units shall have top extruded aluminum grille and two finished sides. Heating elements shall be cal-rod type element installed within aluminum tubes mechanically expanded into aluminum fins and suspended between junction boxes, factory installed raceway, and baked enamel finish in color selected by the Architect.
- C. Manufacturers; QMark, Markel, Berko or preapproved substitute.

2.05 FAN FORCED WALL HEATERS

- A. Unit to be U. L. listed and of the size and capacity indicated on the drawings.
- B. Overheat protection, integral thermostat, nickel chromium alloy heating elements, permanently lubricated motor, 3 position switch.
- C. Finish to be selected by Architect.
- D. Manufacturers: QMark, Markel, Berko, or preapproved substitute.

2.06 ELECTRIC UNIT HEATERS - SUSPENDED

- A. Built in or remote thermostat as indicated on the drawings.
- B. Mounting brackets.
- C. Totally enclosed, permanently lubricated motor.
- D. Element steel finned sheath, zinc plated.
- E. Auto reset cutout, UL listed.
- F. Manufacturer: Markel, Berko, QMark or preapproved equal

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Coordinate locations and rough-in requirements with other trades prior to installation.
- B. Coordinate electrical requirements with the electrical contractor prior to purchasing equipment. Verify voltages and amperages for feeders.
- C. Provide for benchmark construction as described above.
- D. Adjust, place in service, and provide instructions, guarantees, and maintenance manuals to the owner.
- E. Install electrical heat tracing cable in conformance with the manufacturer's recommendations. Test heating circuits before insulating. Arrange with electrical contractor for electrical power circuits.

END OF SECTION

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DIVISION 26 - ELECTRICAL

SECTION 26 00 00 - STANDARD CONDITIONS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.01 REGULATIONS, CODES, STANDARDS

- A. Reference Codes, applicable sections of the following codes and standards shall be considered as binding to the work of this project:
- | | |
|-------|---|
| NEMA | National Electrical Manufacturers' Association |
| NEC | National Electrical Code (NFPA 70) - 2017 Edition |
| NECA | National Electrical Contractors' Association |
| NEIS | National Electrical Installation Standards |
| EGSA | Electrical Generating Systems Association |
| IBC | International Building Code |
| NFPA | National Fire Protection Association |
| IEEE | Institute of Electrical and Electronics Engineers |
| UL | Underwriter's Laboratories, Inc. |
| IES | Illuminating Engineering Society |
| OSHA | Occupational Safety and Health Administration |
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing and Materials |
| FM | Factory Mutual |
| IRI | Industrial Risk Insurers |
| ISO | Insuring Services Office |
| IPCEA | Insulated Power Cable Engineers Assoc. |
| ADA | Americans with Disability Act |
| NETA | International Electrical Testing Association |
- B. All local codes are to be incorporated.
- C. The latest adopted codes and latest editions of standards shall be the basis of conformance.
- D. Obtain and pay for all permits and inspections, and any associated charges.
- E. Inspection Agency Certificate of Inspection to be provided at completion of the work.
Inspection by Middle Department Inspection Agency, Inc., or other local inspection agency.
- F. Drawings, Contract, General Conditions and Supplementary Conditions form a part of this section by reference thereto and shall have the same force and effect as if printed herewith in full. Failure to review these sections shall not relieve the Contractor of his responsibility to fully comply with the terms therein.
- G. Where the contract documents are more stringent but not in conflict with the applicable codes, the more stringent requirements shall be followed.

1.02 SUBMITTALS

- A. The procedure for submissions of shop drawings shall be as specified in Division 1, or as a minimum, as indicated below.
- B. Furnish submissions of shop drawings and samples of materials and equipment as indicated in these sections, on the drawings, or as directed by the architect/ engineer. Submissions will be made in a timely fashion such that adequate time exists to review the drawings, or

- material, and arrive at the site in accordance with the project schedule.
- C. Submissions will not be accepted with work defined as "By Others". Identify contractor by name and with his approval so indicated. Submissions are required prior to purchasing, fabrication, or installation of any material or equipment. Submissions shall be reviewed and certified by the submitting contractor that they are in accordance with the project documents.
 - D. When requested by the engineer, shop drawings shall be required to be submitted to designated agencies for review and approval prior to submission to the engineer.
 - E. Contractor shall arrange and pay for all tests and inspections specified herein or required by above agencies and furnish required certificate of inspection to owner.
 - F. Contractor shall provide performance test data and wiring diagrams of all electrical equipment.
 - G. Submissions shall include warranties by the manufacturer for equipment being provided. Submissions for commonly related items such as fixtures, trim, carriers, shall be combined in a single brochure clearly identifying all items being furnished.
 - H. Shop drawings and submittals shall be checked and stamped by the contractor before submitting. They shall conform to measurements made at the site, the contract requirements, and shall be coordinated with all other trades.
 - I. Specific models in catalog sheets must be identified as well as all options, voltages, phases, etc. identified to be clear as to what is being provided.
 - J. Contractor and manufacturers shall be responsible for all physical characteristics of the equipment and field verify with final locations, coordinate with floor plans, confirm service access, clearances, confirm equipment arrangements, electrical disconnect clearances, and pathways/ travel/ access to the final equipment installation locations. Submission of equipment shop drawing will be deemed evidence of compliance with this requirement. If no shop drawing is submitted, contractor shall be fully responsible for a complete installation and assumes all related costs that affects the contractor and other trades.
 - K. To aid in the preparation of submittals or shop drawings, the engineer can provide the electronic files for use by the contractor. The electronic files will be provided upon execution of the engineer's electronic file release contract prepared specifically for this project. The electronic files will be released in the format used by the architect and engineer to design the project. If this file format is not compatible with the contractor's needs, additional charges for providing the changes to the requested file format may be necessary at \$150.00 per hour billable to the contractor.

1.03 SUBSTITUTIONS

- A. Substitution of other than specified manufacturers shall not be allowed after bid date.
- B. Prior approval is required for other manufacturers. If the contractor wishes for alternate materials or equipment to be considered, he must submit information at least ten days prior to the bid date. If acceptable, an addendum will be issued allowing the contractor to utilize the approved alternate.
- C. Samples shall be provided when directed by the architect or engineer.
- D. If the contractor submits alternate equipment, manufacturers, systems, methods, or materials not specifically identified in the specifications, additional review and investigation time may be required by the engineer. If the engineer determines additional review time is required because of the substitution, then this will be a billable service provided by the engineer at the rate of \$150.00 per hour. Also billable will be any redesign time and revisions to drawings should they be necessary for incorporation into the work. Services will be billable to the contractor making such substitutions and will be payable prior to approval, or rejection.
- E. If the contractor elects to submit alternate equipment, manufacturers, systems, methods, or materials, not specifically identified in the drawings and specifications, it is the contractor's

responsibility to coordinate the work with other trades and pay for any associated costs with the substitution or change.

- F. Contractor and manufacturers shall be responsible for all physical characteristics of the equipment and field verify with final locations, coordinate with floor plans, confirm service access, clearances, confirm equipment arrangements, electrical disconnect clearances, and pathways/travel/access to the final equipment installation locations. Submission of equipment shop drawing will be deemed evidence of compliance with this requirement. If no shop drawing is submitted, contractor shall be fully responsible for a complete installation and assumes all related costs that affects the contractor and other trades.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and equipment in manufacturer's original cartons or on skids.
- B. Store materials in dry enclosure out of way of work progress.
- C. Protect equipment, fixtures, and lenses after placement.

1.05 REFERENCE

- A. Requirements established within the portions of this Project Manual titled Division 1, General Requirements are collectively applicable to the work of this section.
- B. Instructions to Bidders, Special Conditions and Addenda as issued are part of this specification.
- C. Electrical drawings along with all other project drawings represent the work of this Division.
- D. Drawings, Contract, General Conditions and Supplementary Conditions form a part of this section,
by reference thereto and shall have the same force and effect as if printed herewith in full. Failure to review these sections shall not relieve the Contractor of his responsibility to fully comply with the terms therein.

1.06 WORK SUMMARY

- A. Provide labor, materials, equipment, and supervision necessary to install complete, operating electrical systems as indicated on the drawings and specified herein, including all work at the site and within the proposed construction areas to accomplish the require work.
- B. Contractor shall provide all demolition necessary to remove, replace, repair, install new or modify existing work whether it be walls, floors, ceilings, structure, mechanical or electrical required to install his work. Contractor shall replace all work to leave in a finished condition. Pipe, conduit, ductwork, and wiring shall be cut back behind wall surfaces above ceilings and below floor levels so that a patch can be placed over the opening.
- C. ****For Design/Build Projects only**** Provide a full set of electrical design drawings prior to the start of construction indicating all receptacles, luminaires, controls, motors, emergency and exit lighting, fire alarm devices, panels, circuiting, schedules, wire sizes, symbols and abbreviations, single line diagram, details of electrical service and all necessary accessories required to provide a complete electrical system. Provide professional engineer's seal when required by the local authority.
- D. Demolition:
 - 1. Contractor shall disconnect and remove the entire existing electrical system including panels, luminaires, transformer, conduit, wiring, supports, fasteners, starters, fire alarm devices and wiring, telephone equipment and wiring, battery packs, controls, outlets, and devices within the renovation area.
 - 2. Electrical contractor shall verify all existing conditions prior to commencing work.

3. Remove branch circuits back to the power source or the nearest device to remain active. Restore all circuits interrupted by the demolition work to maintain circuit continuity.
 4. Label all overcurrent protection devices made "spare" due to demolition. Update all panelboard directories impacted by the demolition.
 5. Relocate existing branch circuits which interfere with new construction whether specifically identified or not. Refer to architectural drawings for new walls, structure, millwork, etc. which may require existing conduit, wire, etc. to be relocated.
 6. It is the intent that power remain active in adjacent areas during the construction. Contractor is to modify existing wiring arrangement to comply.
 7. All equipment and appurtenances removed are to be disposed of properly. Refer to local, state, and federal requirements.
- E. All work shown on the drawings and not expressly mentioned in the specifications and all work specified but not shown on the drawings, but necessary for the proper execution of same shall be performed by the contractor. It is not the intent of the drawings and specifications to describe every feature and detail of the work.
- F. No additions to the contract amount will be approved for any materials, equipment, or labor to perform additional work unless it can be clearly shown to be beyond the scope and intent of the drawings and specifications.
- G. Provide roof penetrations for electrical work and all associated roof work.
- H. * Provide 3 phase, 4 wire electrical service of the size indicated on the drawings at 480Y/277V with distribution to all equipment at 480V, and luminaires at 277V. Provide step-down transformers for distribution at 208Y/120V and/or 120/240V for 208V/240V loads and 120V for general purpose receptacles.
- I. * Provide 3 phase, 4 wire electrical service of the size as indicated on the drawings at 208Y/120 V with distribution to all equipment 208V, luminaires and general-purpose receptacles at 120V.
- J. Provide (emergency) (stand-by) generator set, (diesel) (natural gas) (propane) (gasoline) powered, automatic transfer switch and all associated controls and appurtenances.
- K. Provide addressable fire alarm system with battery back-up, (horn/ strobes) (speaker/ strobes), pull stations, detectors, strobes, duct detectors, remote annunciator, elevator controls for recall and shutdown of power, telephone auto dialer, firefighter phones, and all associated controls and appurtenances.
- L. Provide fire alarm system with battery backup, horns, strobes, pull stations, annunciator panel, duct detectors, and all associated controls and appurtenances.
- M. Provide power for electric vehicle charger(s) per local jurisdiction.
- N. Provide exit and emergency luminaires throughout with emergency power supply in addition to normal power.
- O. Provide power to HVAC and plumbing equipment as necessary to have complete, operating systems.
- P. Provide luminaires throughout, with exterior luminaires at all egress doors.
- Q. Provide site luminaires for all parking areas, roadways, walkways, as well as security luminaires.
- R. Provide telephone conduit system. Provide (2) CAT 3 plenum rated telephone cables from the telephone demarcation point to the fire alarm control panel for the auto dialer.
- S. Provide Uninterruptible Power Supply System (UPS) with input filter, transformer, battery, and all associated controls and appurtenances.
- T. Provide grounding system for facility in accordance with the NEC.
- U. Provide addressable security system with battery back-up, intrusion detection sensors, signal equipment, system controls, alarm displays, alarm indicating devices, telephone auto dialer, and manual keypads to change system status, wiring methods, and appurtenances.

- V. Provide closed circuit television system to monitor all entrances and exits complete with monitors, cameras, tilt/ pan controller, 16-channel multiplexers, wiring methods, and appurtenances.
- W. Provide communication/ sound system throughout complete with controller, receivers, CD/ tape decks, microphones, speakers, antennae, loudspeakers, equipment racks, wiring methods, and appurtenances.
- X. Base bid is to provide all primary cable, transformer coils, busways, switchboards, panelboards, and all feeders as copper conductors. Alternate bid is to provide all as aluminum conductors of equivalent current carrying capacity.
- Y. Provide code required signage (i.e., NEC 110.34, NEC 700.8, and 695.4 B3).
- Z. Provide third-party certification of all packaged systems by a Nationally Recognized Testing Laboratory (NRTL) in accordance with OSHA Federal Regulations 29CFR1910.303 and .399 as well as Pamphlet #70 and NEC Article 90.7.
- AA. Refer to Commissioning of Systems Specification for additional scope of work.

1.07 SITE INSPECTION

- A. Visit site, inspect, and become aware of all conditions which may affect the work. Investigate utilities, protection requirements for adjacent facilities, storage locations, and access to the construction area.
- B. Submission of a bid will be deemed evidence of being in compliance with this requirement. Contractor may not request additional costs for existing conditions which were evident from inspection of the site.
- C. Before ordering materials or commencing with any work, the contractor shall verify all measurements at the building. Coordination of equipment, materials, spaces, and dimensions are the responsibility of the contractor.

1.08 UTILITY CONNECTION AND CHARGES

- A. The contractor shall be responsible for coordination of the work with the Electric Utility Company. Make all arrangements in a timely fashion for connection of the service.
- B. The Electrical Contractor shall be responsible for utility connection charges, meter charges, and other installation charges as may be applied by the local utility company.
- C. Contact the utility company during the bidding period for connection charges and include same with bid.
- D. Provide connections, terminations, handholes, manholes, pads, transformers, vaults, conduits, wiring, and all required materials and labor as may be required by the utility company to obtain service for the facility. Any costs for service work shall be included in the bid.

1.09 DRAWINGS AND SPECIFICATIONS

- A. Drawings and specifications are intended to be taken as a whole and each is to supplement the other. It is not intended that all work must be both shown on drawings and specified in the specifications.
- B. An item shown on the drawings and not indicated in the specifications is to be understood to be required for the project. An item specified and not shown on the drawings is to be understood to be required for the project.
- C. If there is a conflict between the drawings and specifications it is to be understood that the more strict or more expensive interpretation shall govern. Also, if a conflict exists between specification sections or between drawing plans and details, it is to be understood that the

more strict or more expensive interpretation shall govern.

- D. The architect's or engineer's interpretation of the documents shall be binding upon the contractor. If a question arises, the contractor shall ask for an interpretation prior to bidding and an answer shall be issued as an addendum to all bidders.
- E. If a question arises after bidding the architect's and/ or engineer's interpretation shall govern.
- F. The drawings are generally diagrammatic and necessary field coordination and adjustment must be provided by the contractor prior to installation. Such deviations to the work to allow for coordination shall be kept to a minimum and any such deviations shall be at no extra cost.

1.10 MINIMUM INTEGRATED EQUIPMENT SHORT CIRCUIT RATING:

- A. Where the contract documents indicate secondary service from the utility Company (208/120V, 3 phase, or 480/277V, 3 phase) available short circuit currents including system motor contribution (amperes RMS symmetrical) at the line terminals of the UL service entrance labeled main distribution panelboard or switchboard, shall be in accordance with the following tabulation:

Service Minimum	Service Entrance	Panelboard Rating	Transformer Rating
kVA	%Z	208/ 120V	480/ 277V
75	1.5	14,500	10,000
112.5	1.5	22,000	10,000
125	1.5	29,000	13,000
225	1.5	43,000	19,000
300	1.5	58,000	25,000
500	1.5	96,000	42,000
750	5.5	42,200	18,000
1000	5.5	56,100	24,500
1500	5.5	85,000	37,000
2000	5.5		49,000
2500	5.5		51,000
3000	5.5		73,500

- B. The Integrated Equipment short circuit rating of the main distribution panel, or switchboard shall meet or exceed the tabulated minimum values. This shall be construed to mean that the equipment withstands capability (bus-bracing), and interrupting capacities of main and feeder devices, shall each meet or exceed the tabulated minimum values.
- C. Service transformer ratings shall be as indicated on the drawings. If said ratings are not indicated, the contractor shall contact the engineer and/ or utility company for clarification.
- D. The only deviations from this tabulation that are permissible shall be the results of a short circuit study (if and as specified in Section 26 05 73 Power System Studies), or documented data from the utility company.

1.11 PROGRESS SCHEDULE

- A. Provide a project schedule which shall show start, sequence of each type of work, milestone schedule, and completion of each type of work, with overall completion date.

1.12 COST SCHEDULE

- A. Provide a detailed cost breakdown indicating labor and material amounts for various types of work.
- B. AIA forms are required for this submission.

1.13 OFFICE

- A. The contractor shall set up his job office (desk) where directed by the owner.

1.14 STORAGE

- A. Material shall be stored only where directed by the owner.

1.15 SANITARY

- A. The contractor will at his own expense, provide and maintain in a sanitary condition, a portable chemical toilet.
- B. Toilet will be located where directed by the owner.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials and equipment shall be new and in present production of major manufacturers.
- B. All materials and equipment shall be in conformance with accepted trade standards as a minimum. Where specifications exceed any minimum standard, the specifications shall govern.
- C. Reference of equipment in the singular shall be deemed to apply to as many such items as may be required to complete the work.
- D. The word "provide" means "furnish and install complete, tested, and adjusted as necessary with all accessories, wiring methods, switching, lenses, mounting hardware, cover plates, hangers and supports".

2.02 FASTENERS AND SUPPORTS

- A. All work shall be securely fastened to building construction.
- B. Utilize toggle or machine bolts in hollow construction.
- C. Utilize machine screws for steel construction.
- D. Utilize expansion shields for masonry construction.
- E. Utilize lag bolts for wood construction.
- F. All fasteners shall be galvanized or plated with rustproof finish.
- G. Maximum load on fasteners shall be at a safety factor of 4:1 for a tested sample.

2.03 MOTOR STARTERS AND CONTACTORS

- A. Single-phase manual motor starters with overloads shall be provided under the electrical portion of the work for fractional horsepower motors up to ½ HP.
- B. Polyphase motor starters and motor starters above ½ HP shall be furnished under other portions of the work.

- C. The starters in A, or B above shall be installed under the electrical portion of the work.
- D. Polyphase starters shall be magnetic combination type, across-the-line, electrically operated, electrically held, three-pole assemblies, with arc-extinguishing characteristics, silver-to-silver renewable contacts, three-pole thermal bi-metallic, red "run" pilot light, individual phase protection, with overload heaters matched to motors installed and with four auxiliary contacts, Hand-Off-Auto switch, and control transformer.
- E. For single-phase motors above ½ HP provide magnetic combination, single-phase motor starters with overloads, non-fusible disconnect switch, red run pilot light, integral 120 volt control transformer with dual primary fusing, auxiliary contacts.
- F. Starters shall be as manufactured by G.E., Cutler Hammer, Siemens, Square D or Allen Bradley.
- G. Contactors shall be across-the-line, electrically operated, mechanically held three-pole assemblies for tungsten and ballast luminaire loads. Acceptable manufacturers: GE, Cutler Hammer, Siemens, Square D or Allen-Bradley.
- H. Manual motor starters without overloads in NEMA 1 enclosure equal to G. E. Type TC shall be used for the following load:
 - 1. 30 amperes or less, continuous.
 - 2. 1 HP or less at 120 volts
 - 3. 2 HP or less at 240 volts

2.04 MANUFACTURERS' NAMES

- A. Manufacturers' names are included herein to establish those suppliers who may provide products for this project subject to the requirements of the specifications. Although a manufacturer's name may appear as an acceptable supplier it is not understood that a standard product is acceptable. Products must also meet the technical, performance, and physical requirements of the project as well as being named in the specification. Any deviations from this must be acknowledged during the bid phase by the supplier, who shall be solely responsible for any and all costs associated with the application of their product(s) in the project.
- B. A design cannot be prepared which accommodates the installation of all suppliers and is not intended to do so. If certain modifications must be made to accommodate one particular supplier's equipment it shall be considered the contractor's responsibility to arrange for such accommodations and be financially responsible for same.

PART 3 - EXECUTION

3.01 WELDING

- A. All electric power for arc welding shall be supplied by the contractor performing the work.

3.02 VEHICLES

- A. Vehicle access to the site will be as directed by the owner.

3.03 RUBBISH DISPOSAL

- A. Except for items or materials identified to be reused, salvaged, reinstalled, or otherwise

indicated to remain property of the owner or tenant, demolished materials shall become the contractor's property and shall be removed, recycled, or disposed from the project site in an appropriate and legal manner.

- B. Burning of debris on the site shall not be permitted. All debris, refuse, and waste shall be removed from the premises at regular intervals. No accumulation shall be permitted.

3.04 WORKMANSHIP

- A. Maintain all public walks and access ways.
- B. Erect and maintain barricades, warning signs, and other protective means as may be directed by the owner for protection of all persons and property from injury or damage.
- C. Plug or cap open ends of piping systems and conduit.
- D. Stored materials shall be covered to prevent damage by inclement weather, sun, dust, or moisture.
- E. Protect all installed work until accepted in place by the owner. Protect luminaires.
- F. Do not install plates, covers, and other finished devices until masonry, tile, and painting operations are complete, or protect otherwise.
- G. Protect all existing or new work from operations which may cause damage such as hauling, welding, soldering, painting, insulation and covering.
- H. All devices and exposed raceways are to be plumb and true. All exposed raceways in finished areas are to be coordinated with the architect/engineer prior to installation.

3.05 SCAFFOLDING

- A. The contractor shall at his own expense, install, operate, protect, and maintain temporary services such as scaffolding, material hoists, access walks, etc., as may be required.

3.06 SITE UTILITIES

- A. The contractor may use the existing water and electric power for temporary construction needs.
- B. The owner will direct where these services may be tapped.
- C. Those services that are used during construction, but are to remain, shall be refurbished to a new condition before turning back over to the owner.

3.07 CLEAN-UP

- A. Remove all visible temporary tags or labels as well as any protective coverings and wrappings from fixtures and equipment.
- B. Remove all spots, stains, soil, paint, spackle, and other foreign matter from all finished work.
- C. Remove all trash and debris from the premises.

3.08 LUBRICATION

- A. Furnish and install and maintain all required lubrication of any equipment operated prior to acceptance by the owner. Lubrication shall be as recommended by the equipment manufacturer.
- B. Provide one year's supply of lubricants to owner at date of acceptance.
- C. Verify that required lubrication has taken place prior to any equipment start-up.

3.09 EQUIPMENT START UP

- A. Verify proper installation by manufacturer or his representative.
- B. Advise the architect and engineer two days prior to actual start up.
- C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to the architect and engineer.

3.10 OPERATING INSTRUCTIONS AND MANUALS

- A. Properly and fully instruct owner's personnel in the operation and maintenance of all systems and equipment.
- B. Ensure that the owner's personnel are familiar with all operations to carry on required activities.
- C. Such installation shall be for each item of equipment and each system as a whole.
- D. Provide report that instruction has taken place. Include in the report the equipment and/ or systems instructed, date, contractor, owners' personnel, vendor, and that a full operating and maintenance manual has been reviewed.
- E. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalog cuts, wiring diagrams, piping diagrams, control sequences, service requirements, names and addresses of vendors, suppliers, and emergency contacts. Three manuals shall be provided to owner.
- F. Submit manuals for review prior to operating instruction period. Manuals shall be 8 1/2" x 11" with hard cover, suitably bound.
- G. Provide to the owner any special tools necessary to operate any of the equipment.

3.11 PENETRATION SEALING

- A. All penetrations of Natatorium walls, fire walls, smoke walls, and floors shall be sealed around conduits and wiring to prevent the flow of gases or smoke.
- B. The sealant shall be foamed in place between the conduit or wiring and the adjacent walls and floors with Dow/ Corning RTV foam or Fire Stop Caulk.
- C. All penetrations through roof structure shall be coordinated with other trades to minimize the potential for water seepage and leakage through such penetrations.
- D. When electrical boxes are located on opposite side of a fire resistance rated wall assembly are within 2'-0" horizontally of each other, both devices are to be wrapped with Spec Seal Putty Pads as manufactured by Specified Technologies, Inc., or approved equivalent.

3.12 EQUIPMENT SETTING

- A. Furnish and install as a minimum, a 0'-4" high concrete pad beneath all floor-mounted equipment.
- B. Furnish and install as a minimum, spring vibration isolators under any equipment 10 HP and over and rubber-in-shear vibration isolation under all equipment less than 10 HP.
- C. Reinforce concrete with No. 4 rods 12'-0" on center, both ways.
- D. Pad to have 3/4" dowels into concrete at one per four square feet.

3.13 INSTALLATION MOUNTING HEIGHTS

- A. To be verified by Architect, but in general shall be as follows (top of device elevation above finished floor):

Lighting switches, controls:	3'-10"
Duplex receptacles:	1'-8"
Duplex receptacles over counters:	0'-8" above countertop
Telephone data wall plate and modular jack, desk phone:	1'-8"
Telephone, data wall plate and modular jack, wall phone:	3'-10"
Special outlets:	As required for equipment
Fire alarm annunciating devices:	85"
Fire alarm manual pull stations:	3'-10"
Clock receptacles:	As indicated on drawings.
CATV wall plates and modular jacks:	1'-8"
CATV wall plates and modular jacks mounted near ceiling:	Coordinate mounting height with Architect.
Thermostats (forward reach):	3'-10"
Thermostats (side reach):	3'-10"
Thermostats with lockable cover:	4'-6"

Requirements of the Americans with Disability Act and/or ANSI A117.1 shall be met.

- B. Structural and mechanical details shall be coordinated before roughing in.

3.14 COORDINATION

- A. Coordinate with work of other trades prior to installation.
B. Arrange for minor variations for complete coordinated installation. Provide all necessary offsets to install the work and to provide clearances for other trades.

3.15 CUTTING AND PATCHING

- A. Provide for cutting and patching for all electrical work.
B. Patching to be performed by tradesmen skilled in that particular trade.
C. Contractor shall patch and repair any existing openings created by the demolition work in floors, walls, partitions, and ceilings not being reused for the new construction.

3.16 BALANCING AND TESTING

- A. Electrically balance connected loads in panels.
B. The entire wiring system shall be tested to be free from grounds and faults.
C. Identify all circuits and all phase wiring at terminations.

3.17 EQUIPMENT FURNISHED BY OTHERS

- A. This contractor shall make final electrical connections to equipment furnished by other contractors or the owner.
B. Provide electrical service, and disconnect equipment as required by code to supply such equipment.

3.18 EXCAVATION, SHORING, PUMPING, BACKFILLING

- A. Perform all excavation required to install the work. Deposit excavated material as so not to create a slide hazard.
- B. Maintain excavations free of water.
- C. Backfill with clean material and pneumatically tamp in 0'-8" layers. Remove excess material, including rock, from site or as directed by the architect and engineer.
- D. Return to original conditions any areas disturbed for excavation.
- E. Install all work neatly, trim, and plumb with building lines.
- F. Install work in spaces allocated.
- G. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.

3.19 RECESSES

- A. Furnish information to the General Contractor as to sizes and locations of recesses required to install panels, boxes, grilles, and other equipment, and/ or devices which are to be recessed in walls.
- B. Make offsets or modifications as required to suite final locations.

3.20 LABELING

- A. All equipment panels, controls, safety switches, and devices shall be provided with permanent black laminated micarta white core labels with 3/8" high letters.
- B. This shall also apply to all controllers, remote start/ stop pushbuttons, equipment cabinets, and wherever directed by the architect and engineer.
- C. This shall not apply to individual room thermostats, and local light switches.

3.21 GUARANTEE

- A. All work shall be guaranteed to be free from defects for a period of one year of operation from date of acceptance by the owner unless otherwise specified.
- B. Guarantee shall be extended for all non-operational periods due to failure within the guarantee period.

3.22 AS BUILT DRAWINGS

- A. At the completion of the work and prior to final payment, the contractor shall furnish a reproducible as-built drawing to the architect and engineer for approval. The drawings shall indicate all work installed and its actual size, and location and identify all systems installed with locations of concealed devices, conduit, piping and other equipment and complete wiring diagrams of all systems. If acceptable, the architect and engineer will submit the as-built drawings to the owner as record drawings. If not acceptable, the architect and engineer return the drawing to the contractor to make corrections as required. The contractor will resubmit for approval.
- B. The as-built drawings shall indicate measured dimensions of underground lines and other concealed work.
- C. To aid in the preparation of as-built drawings, the engineer can provide the electronic files for use by the contractor. The electronic files will be provided upon execution of the engineer's electronic file release contract prepared specifically for this project. The electronic files will be released in the format used by the architect and engineer to design the project. If this file format is not compatible with the contractor's needs, additional charges for providing the changes to the requested file format may be necessary at \$150.00 per hour billable to the

contractor.

3.23 SAMPLE CONSTRUCTION

- A. (One double and one single patient room) (one apartment) (one tenant space) shall be constructed and approved by the owner, architect/ engineer, and local code officials (electrical inspector or underwriter, building code official, fire marshal) before all other rooms are constructed.
- B. This room shall represent the standard against which all others will be constructed.
- C. Installation will include all units, ducts, piping, wiring, fixtures, devices, etc. which are required for complete rooms.

3.24 MAIN ELECTRICAL ROOM DRAWING

- A. Provide 3/8" = 1'-0" scale drawings of the Main Electrical Room indicating all electrical, mechanical, plumbing, telephone, security, fire alarm and life safety equipment to be installed within this room. Exact dimensions of equipment, pads, etc., are to be indicated. Show two cross sections at important points.
- B. Obtain information from other subs as appropriate.
- C. Submit for review and approval along with electrical equipment submittals. Equipment will not be approved prior to review of this drawing.

3.25 GENERAL ELEVATOR REQUIREMENTS

- A. The Electrical Contractor shall furnish and install an elevator safety switch sized to match the requirement of the elevator motor. Switch shall be located within the Elevator Machine Room on the strike side of the entrance doorway. The Electrical Contractor shall provide the branch circuit to the safety switch and make terminations between the switch and the elevator motor.
 - 1. For machine room less equipment, Switch shall be located within the Elevator Control Space.
- B. Furnish and install a 20 Amp dedicated circuit and disconnect switch for the elevator cab(s) lighting system. The disconnect switch is to be located within the Machine Room on the strike side of the entrance doorway. This circuit is to be ground fault protected.
 - 1. For machine room less equipment, Switch shall be located within the Elevator Control Space.
- C. Furnish and install a dedicated 20 Amp circuit for the elevator pit and Machine Room. Furnish and install GFCI receptacle and two, 2'-0" L LED strip luminaires located within the elevator pit (final quantity shall be as required to provide minimum illuminance per the elevator manufacturer). Pit devices and luminaire control are to be located adjacent to pit access.
 - 1. For machine room less equipment, GFCI device shall be located within the Elevator Control Space. Luminaire and control shall not be required within the Elevator Control Space.
- D. Furnish and install a telephone back box and conduit in the Elevator Machine Room for the elevator cab telephone circuit and local telephone jack.
 - 1. For machine room less equipment, telephone back box and conduit for the elevator cab telephone circuit and local telephone jack shall be located within the Elevator Control Space.
- E. Furnish and install smoke detectors for elevator recall at each elevator lobby when building is three stories or more. These automatic initiation devices are to be interlocked with elevator controller and building Fire Alarm Control Panel. Heat detectors are to be provided in the

Machine Room and at the top and bottom of the elevator shaft.

1. For machine room less equipment, devices associated with the Machine Room shall not be required.
- F. When an automatic sprinkler system is present, automatic initiation devices for elevator power shut down are to be provided. These heat detectors are to be located within 2'-0" of all sprinkler heads in the Elevator Machine Room and Elevator Shaft. See Elevator Shunt Trip paragraph for further requirements.
1. For machine room less equipment, devices associated with the Machine Room shall not be required.
- G. Furnish and install fire rated enclosures for the back boxes of any electrical devices recessed in the walls of the elevator equipment room or shaft. Walls are fire rated.
- H. Furnish and install two 20 Amp 120V circuits for sump pump and sump pump alarm. Coordinate with plumbing contractor.

3.26 ELEVATOR SHUNT TRIP (SPRINKLED BUILDING)

- A. The elevators are required to be provided with a shunt trip circuit breaker serving the equipment. All feeder circuit breakers (both on normal and emergency/standby power sources) are to be provided with the shunt trip device. The activation of the shunt trip is to be in the sequence described below.
1. Upon activation of the fire alarm system by any manual or automatic means, including the smoke detectors required for recall, a signal is sent from the fire alarm control panel to the elevator controller to initiate recall of the elevator to the lowest non-fire floor. Upon activation of the 135°F heat detector located within 2'-0" of all sprinkler heads in either the Elevator Machine Room, the Elevator Pit or the top of the shaft, a signal is sent from the fire alarm control panel to immediately shunt-trip the power supply. This sequence will allow the elevator to be recalled to the lowest non-fire floor before the shunt trip is activated. The sprinkler heads in the Elevator Machine Room and elevator shaft are to be rated at 200°F, which will allow the shunt trip to activate prior to the sprinkler head.

3.27 WORK COMPLETION

- A. The contractor shall promptly correct work rejected by the engineer or failing to conform to the requirements of the contract documents, whether discovered before or after Substantial Completion and whether or not fabricated, installed, or completed. Costs of correcting such rejected work, including additional testing and inspections and compensation for the engineer's services and expenses made necessary thereby, shall be at the contractor's expense.

3.28 REQUEST FOR INFORMATION (RFI) REQUIREMENTS

- A. All RFI's shall include the following information based on AIA Document G716:
1. To, From, Project Name, Issue Date, RFI number in sequential order with all other trades, Requested Reply Date.
 2. Provide a description with specification and/or drawing references.
 3. Provide the senders recommendation including cost and/or schedule considerations.
 4. Provide receiver's reply space.
 5. Note an RFI reply is not an authorization to proceed with the work involving additional cost/time.

3.29 SHOP DRAWING REQUIREMENTS

A. The following is a list of required shop drawings for this project.

ELECTRICAL	DATE REC'D	ACTION	DATE REC'D	ACTION
Basic Materials and Equipment (Section 26 05 00 and 26 27 00)				
Fusible Switchboard (Section 26 24 13)				
Panelboards (Section 26 24 16)				
Safety Switches - (Section 26 28 16)				
Automatic Transfer Switch (Section 26 36 23)				
Transformers (Section 26 22 00)				
Surge Suppression (Section 26 43 13)				
Lighting (Section 26 50 00 and 26 09 00)				
Lightning Protection (Section 26 41 13)				
Emergency Power System (Section 26 30 00)				
Static Uninterruptible Power Supply (Section 26 33 53)				
Fire Alarm and Detection Systems (Section 28 30 00)				
Low Voltage Systems (CCTV, Security, DATA, Phone Entry, etc.)				
As-Builts				
Warranties				
Maintenance Manuals				
Instructions				
Ground Test				

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING SYSTEMS: GENERAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of system described in other Sections.

1.03 SUBMITTALS

- A. Product Data - For the following:

1. Ground rods.
2. Chemical rods.

- 1.04 Qualification Data: For firms and persons specified in 1.05 QUALITY ASSURANCE Article.

- A. Field Test Reports: Submit written test reports to include 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.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association 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 - EXECUTION.
- 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. Comply with UL 467.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Chance/ Hubbell
 - b. Copperweld Corp.
 - c. Erico Inc.; Electrical Products Group.
 - d. Framatome Connectors/Burndy Electrical
 - e. Galvan Industries, Inc.
 - f. Ideal Industries, Inc.
 - g. Kearney/ Cooper Power Systems.
 - h. Korns: C.C. Korns Co.; Division of Robroy Industries.
 - i. Lyncole XIT Grounding.
 - j. O-Z/Gedney Co.; a business of the EGS Electrical Group.\
 - k. Raco, Inc.; Division of Hubbell.
 - l. Salisbury: W.H. Salibury & Co.
 - m. Superior Grounding Systems, Inc.
 - n. Thomas & Betts, Electrical

2.02 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Section 26 27 00.
- B. Material: Aluminum, copper-clad aluminum, and copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two band of yellow.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- G. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B 3.
 2. Assembly of stranded Conductors: ASTM B8.
 3. Tinned Conductors: ASTM B33.
- H. Copper Bonding Conductors: As follows:
1. Bonding Cable: 28 kcmil, 14 strands of #17 AWG copper conductor, 1/4" Ø.
 2. Bonding Conductor: #4 or #6 AWG, stranded copper conductor.
 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules: 1-5/8" wide and 1/16" thick.
 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules: 1-5/8" wide and 1/16" thick.
- I. Aluminum Bonding Conductors: As follows:
1. Bonding Cable: 10 strands of #14 AWG aluminum conductor 1/4" Ø.
 2. Bonding Conductor: #4 or #6 AWG, stranded aluminum conductor.
 3. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules: 1-5/8" wide and 1/16" thick.
- J. Ground Conductor and Conductor Protector for Wood Poles: As follows:
1. #4 AWG aluminum, soft-drawn copper conductor.
 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, cypress, or cedar.
- K. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.03 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per

2.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.
- B. Ground Rods: Section type; copper-clad steel.
 - 1. Size: 5/8" Ø.
- C. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a #4/0 bare conductor. Provide backfill material recommended by manufacturer.

PART 3 - EXECUTION**3.01 APPLICATION**

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Use insulated spacer; space 0'-1" from wall and support from wall 0'-6" above finished floor, unless otherwise indicated.
 - 2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.
- F. Underground Grounding Conductors: Use tinned copper conductor, #2/0 AWG minimum. Bury at least 2'-0" below grade or bury 1'-0" above duct bank when installed as part of the duct bank.

3.02 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
 - 1. Feeders and branch circuits.
 - 2. Single-phase motor branch circuits.
 - 3. Three-phase motor branch circuits.
- D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- E. Bond metal parts, motor frames, fittings, plumbing pipes, drains, metal conduit, metal surfaces within

5'-0", and all electrical devices and controls within 5'-0".

- F. Motors shall be grounded by means of a grounding conductor in the same raceway with the motor feeder connected to the grounding bushing at the motor terminal box and the ground bus in the motor control center or to the incoming conduit grounding bushing of an individually mounted motor starter.

3.03 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.04 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For #8 AWG and larger, use pressure-type grounding lugs. #10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
 - 1. Tighten screws and bolts for grounding and bonding 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.
- E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- F. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.05 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81. (Ensure that the test is performed with all ground-to-neutral bands broken. The grounding system must be completely isolated for the test to be valid.)
 3. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 73 - POWER SYSTEM STUDY**PART 1 - GENERAL****1.01 GENERAL**

- A. Short Circuit Studies, Protective Device Evaluation Studies, Protective Service Coordination Studies and Arc Flash Hazard Studies shall be performed by the switchboard/ switchgear manufacturer. The studies shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture.
- B. The studies shall include all portions of the electrical distribution system from the utility service at the facility through the utility transformer, main service entrance rated equipment, distribution and branch panelboards, motor control centers, significant motor loads, generators, and all emergency power distribution. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- C. The Short Circuit Study shall be developed in accordance with ANSI C37.5-1969 (R1975), IEEE Standard. 399-1980 and IEEE Standard 141-1976.

1.02 SHORT CIRCUIT STUDY

- A. The short circuit study shall be performed with the aid of a digital computer program.
- B. The short circuit study input data shall include the utility company's short circuit contribution, resistance and reactance component of the branch impedances, the X/ R ratios, base quantities selected and other source impedances.
- C. Short circuit momentary duty values and interrupting values shall be calculated on the basis of assumed three-phase bolted short circuits at each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, pertinent branch circuit panel and other significant locations throughout the system (i.e., chillers, fire pumps, elevators, etc.). The short circuit tabulations shall include symmetrical fault currents and X/ R ratios. For each vault location, the total duty on the bus in addition to the individual contribution from each connecting branch shall be listed with its respective X/ R ratio.

1.03 PROTECTIVE DEVICE COORDINATION STUDY

- A. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or check the selection of power fuse ratings, protective relay characteristics of associated current transformers and low voltage circuit breaker trip characteristics and settings. The objective of the study is to obtain optimum protective and coordination performance from these devices.
- B. The coordination study shall include all medium and low voltage classes of equipment from the utility incoming line protective device down to and including the largest rated 480-volt and 208-volt motor control center, distribution switchboards, panelboards and individual switches and circuit breakers. The phase and ground over current protection shall be included as well as settings of all other adjustable protective devices.
- C. The time-current characteristics of the specified protective devices shall be drawn on Keuffel and Esser log paper. The plots shall include complete titles representative of one-line diagrams and legends, associated utility company's relay or fuse characteristics, significant

motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal over current withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the NFPA 70 National Electrical Code shall be adhered to, and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be supplied on a system basis. A significant number of separate curves shall be used to clearly indicate the coordination achieved.

- D. The selection and settings of the protective devices shall be provided separately in a tabular form listing circuit identification, IEEE Device number, current transformer ratios and connections, manufacturer and type, range of adjustment and recommended settings. A tabulation of the recommended power fuse selection shall be provided for the medium voltage fuses where applied in the system. Any discrepancies, areas of coordination conflict or other inadequacies shall be promptly brought to the Engineer's attention.

1.04 PROTECTIVE DEVICE EVALUATION STUDY

- A. A protective device evaluation shall be performed to determine the adequacy of power circuit breakers, molded case circuit breakers, switches, automatic transfer switches and fuses by tabulation of all devices and comparing such device ratings with calculated fault currents.

1.05 ARC FLASH EVALUATION STUDY

- A. Provide an Arc Flash Hazard Study for the electrical distribution system. The study shall include all medium and low voltage classes of equipment from the utility incoming equipment down to and including all motor control centers, switchboards, panelboards, individual switches and circuit breakers and load centers.
- B. The study shall include creation of Arc Flash Hazard Warning Labels. The label shall include the following:
 - 1. Flash Hazard Protection Boundary
 - 2. Limited Approach Boundary
 - 3. Restricted Boundary
 - 4. Prohibited Boundary
 - 5. Incident Energy Level
 - 6. Required Personal Protection Equipment Class
 - 7. Type of fire rated clothing
 - 8. Equipment name
 - 9. Equipment voltage
- C. The label shall be printed in color and shall be moisture-proof adhesive backed vinyl.

1.06 REPORTS

- A. The results of the power system study shall be summarized in a final report. Electronic copy of the final report shall be submitted to the Engineer.
- B. The report shall include the following sections:
 - 1. Description, purpose, basis and scope of the study and a single line diagram of the portions of the power system which is included in the scope of the study.
 - 2. Tabulation of circuit breaker, fuse and other protective device ratings compared to calculated short circuit duties with commentary regarding same.

3. Protective device time versus current curves, tabulation of relay and circuit breaker trip settings, fuse selection with commentary regarding same.
4. Fault current calculations including a definition of terms and guide for interpretation of computer printouts.
5. Arc Flash Evaluation Summary Spreadsheet.
6. Arc Flash Hazard Warning Labels.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.01 COORDINATION

- A. The power system study is to be performed prior to release of equipment for manufacturer.
- B. Electrical contractor is to adjust all circuit breaker trip settings as indicated by the study.
- C. Electrical contractor is to ensure proper rating of all equipment prior to installation.
- D. Electrical contractor is to install the Arc Flash Hazard Warning Labels.

END OF SECTION

SECTION 26 09 00- LIGHTING CONTROLS

PART 1 - GENERAL

1.01 REFERENCE

- A. This section includes manually operated, digital lighting controls with external signal source, relays, and control module.
- B. Refer to Section 26 00 00 for other requirements of this section.
- C. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.
- 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 47 CFR, Subparts A and B, for Class A digital devices.
- F. Comply with NFPA 70 National Electrical Code (NEC).
- G. Refer to 26 27 00 for other lighting controls (switches, motion sensors, etc.).
- H. Provide interior lighting controls to meet the adopted IBC / IECC / ASHRAE 90.1 code.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to furnish and install complete, operating, lighting control system specified herein.
- B. All rooms are to be provided with lighting controls. Provide manual switch and code required control devices as appropriate. If controls are not indicated within a space, controls are to be provided for the space in a similar manner as adjacent or similar spaces.

1.03 SUBMITTALS

- A. Product Data: For control modules, power distribution components, manual switches and plates, and conductors and cables.
- B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on this Project.
 - 1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
- C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and system specified in other Sections.
 - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
 - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet inter-operability requirements of

- the network protocol.
- 3. Show equipment locations on floor plans of similar scale as contract documents.
- D. Field quality control test reports.
- E. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.
- F. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.04 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of lighting control functions.
 - 2. Coordinate lighting controls with HVAC controls. When specifically indicated on lighting control system riser diagram, design display graphics showing building areas controlled; include the status of lighting controls in each area.
 - 3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of software input/output to execute switching or dimming commands.
 - b. Failure of modular relays to operate under manual or software commands.
 - c. Damage of electronic components due to transient voltage surges.
 - 2. Warranty Period: Two years from date of Substantial Completion.

1.06 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Watt Stopper (The).
 - 2. Leviton Mfg. Company Inc.
 - 3. Hubbell Lighting Controls.
 - 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 5. Lutron Electronics Company, Inc.

- 6. ETC Lighting Control Systems.
- 7. WaveLinx.

2.02 SYSTEM REQUIREMENTS

- A. Expandability: System shall be capable of increasing the number of control functions in the future by 25 percent of current capacity; to include equipment ratings, housing capacities, spare relays, terminals, number of conductors in control cables, and control software.
- B. Performance Requirements: Manual switch operation, an internal timing and control unit and external sensors, send a signal to Programmable system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

2.03 CONTROL MODULE

- A. * Control Module Description: Comply with UL 508 (CSA C22.2, No. 14); Microprocessor based, programmable, control unit; mounted in preassembled, modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays shall be prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays. Control units shall be capable of receiving inputs from sensors and other sources. Line-voltage components and wiring shall be separated from low-voltage components and wiring by barriers. Control module shall be locally programmable.

2.04 POWER DISTRIBUTION COMPONENTS

- A. Modular Relay Panel: Comply with UL 508 (CSA C22.2, No. 14) and UL 916 (CSA C22.2, No. 205); factory assembled with modular single-pole relays, power supplies, and accessory components required for specified performance.
 - 1. Cabinet: Steel with hinged, locking door.
 - a. Barriers separate low-voltage and line-voltage components.
 - b. Directory: Mounted on back of door. Identifies each relay as to load groups controlled and each programmed pilot device if any.
 - c. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.
 - 2. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type.
 - a. Low-Voltage Leads: Plug connector to the connector strip in cabinet and pilot light power where indicated.
 - b. Rated Capacity (Mounted in Relay Panel): 20 A, 125-V ac for tungsten filaments; 20 A, 277-V ac for ballasts.
 - c. Endurance: 50,000 cycles at rated capacity.
 - d. Mounting: Provision for easy removal and installation in relay cabinet.

2.05 MATERIALS

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 27 00 Section "BASIC MATERIALS."
- B. Class 1, 2, and 3 Control Cables: Multi-conductor cable with copper conductors as recommended by the manufacturer.
- C. Control wiring methods are to be per approved brand and part number of the lighting control

- manufacturer. No substitutions will be permitted.
- D. Manual Controllers: Comply with Division 26 27 00 Section "BASIC MATERIALS."

PART 3 - EXECUTION

3.01 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring in raceways except where installed in accessible ceilings.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- E. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

3.02 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 assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Test for circuit continuity.
 - 2. Verify that the control module features are operational.
 - 3. Check operation of local override controls.
 - 4. Test system diagnostics by simulating improper operation of several components.

3.03 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

3.04 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.05 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems.

END OF SECTION

SECTION 26 22 00 - TRANSFORMERS DRY TYPE (DOE 2016)

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to section 26 00 00 for requirements which are applicable to this section.
- B. Refer to National Electrical Code

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to install and place into operation dry type transformers of the size and capacity indicated on the drawings.

1.03 SUBMITTALS

- A. Submit shop drawings of transformer.
- B. Submit manufacturers' certificates of conformance with applicable codes.
- C. Submit wiring diagrams of transformer.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.
- B. Install equipment in accordance with the NEC.

PART 2 - PRODUCTS

2.01 LIGHTING AND POWER TRANSFORMERS

- A. Furnish and install, as indicated on the electrical plans, energy efficient dry-type transformers as manufactured by Square D Company, or approved equal by Siemens, Eaton, ABB Group, ACME Electric CORP., Hammond Power Solutions, Inc., Jefferson Electric, Inc., MGM Transformer Co., Mirus International Inc., Powersmith International Corp.
- B. Single phase transformers shall be 480 volt primary and 120/208 volt secondary. Three phase transformers shall be 480 delta primary and 208Y/120 secondary. Transformers 15 kVA and larger shall have a minimum of 4-2 1/2 percent full capacity primary taps. Exact voltages and taps to be as designated on the plans or the transformer schedule.
- C. Transformers 15 kVA and above shall be 150° C temperature rise above 40° C ambient. All insulating materials to be in accordance with NEMA ST20 standards for a 220° C UL component recognized insulation system. Transformer shall be a low loss type with minimum efficiencies per DOE 2016 requirements.
- D. Transformer coils shall be of the continuous wound copper construction and shall be impregnated with nonhygroscopic, thermosetting varnish.

- E. All cores to be constructed of high grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be clamped together with structural steel angles. The completed core and coil shall then be bolted to the base of the enclosure but isolated therefrom by means of rubber, vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure. On transformers 500 kVA and smaller, the vibration isolating system shall be designed to provide a permanent fastening of the core and coil to the enclosure. Sound isolating systems requiring the complete removal of all fastening devices will not be acceptable.
- F. Transformers 15 kVA and larger shall be in a heavy gauge, sheet steel, ventilated enclosure. The ventilating openings shall be designed to prevent accidental access to live parts in accordance with UL, NEMA, and National Electrical Code standards for ventilated enclosures. Transformers through 75 kVA shall be designed so they can be either floor or wall mounted. Above 75 kVA they shall be floor mounted design.
- G. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed, and finished with a grey, baked enamel.
- H. The maximum temperature of the top of the enclosure shall not exceed 50° C rise above a 40° ambient.
- I. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards.
- J. Sound levels shall be guaranteed by the manufacturer not to exceed the following:
 - 1. 15 to 50 kVA - 45 DB
 - 2. 51 to 150 kVA - 50 DB
 - 3. 151 to 300 kVA - 55 DB
 - 4. 301 to 500 kVA - 60 DB
- K. The transformer shall be listed by Underwriters' Laboratory for the specified temperature rise.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

3.02 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer

manufacturer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounted transformers according to manufacturer's written instructions. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.03 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. 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-486B.
- C. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 13 - FUSIBLE SWITCHBOARD

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to section 26 00 00 for requirements which are applicable to this section.
- B. Refer to the National Electrical Code.
- C. Refer to the requirements of the Utility Co.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to furnish and install a fusible distribution switchboard.

1.03 SUBMITTALS

- A. Submit shop drawings of equipment specified in this section.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.

PART 2 - PRODUCTS

2.01 FUSIBLE DISTRIBUTION SWITCHBOARDS

A. GENERAL:

Furnish and install the (service entrance) (distribution) switchboard(s) as herein specified and shown on the associated electrical drawings. The switchboard(s) shall meet Underwriters' Laboratories enclosure requirements and be furnished with an Underwriters' Laboratories label. The entire switchboard is to be Square D QMB fusible construction.

B. ENCLOSURE CONSTRUCTION:

The switchboard shall be dead-front with (front and rear accessibility) (front accessibility) required. The switchboard framework shall consist of steel channels bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. The framework is to be formed of code gauge steel, rigidly welded together to support all cover plates, bussing and component devices. Each switchboard shall have an open bottom and an individual removable top plate for installation and termination of conduit. Top and bottom conduit areas are to be clearly shown and dimensioned on the shop drawings. The wireway

front covers shall be hinged to permit easy access to the branch fusible switch load side terminals. The paint finish shall be medium light gray, ANSI #49, applied by the electrodeposition process over an iron phosphate pre-treatment. (A NEMA 3R enclosure for the switchboard shall be provided.)

C. BUSSING:

The switchboard bussing shall be of sufficient cross-sectional area to meet UL Standard 891 on temperature rise. Through bus shall be (plated copper) (extruded aluminum plated by the Alstan 70 or 80 process). The through bus shall have an ampacity of (1200) (2000) (3000) (4000) (5000 copper only) amperes and shall be braced to have a short circuit current rating of (50,000) (100,000) (200,000) RMS symmetrical amperes. (The through bus shall have provisions for the addition of future sections.) The through bus supports, connections and joints are to be bolted with Hex head bolts and Belleville washers to minimize maintenance requirements.

D. SHORT CIRCUIT CURRENT RATING:

Each switchboard, as a complete unit, shall be given a single short circuit current rating (fully rated) equal to or greater than the rating indicated on the drawings. Such rating shall be established by actual tests by the manufacturer, in accordance with UL specifications, on equipment constructed similarly to the subject switchboard.

E. FUSIBLE SWITCHES (30-600 AMPERES):

The fusible switches shall be quick-make, quick-break and shall be group mounted in panel-type construction. Switches of 30-200 amperes shall have plug-on line side connections and shall have built in fuse pullers (30-100A units). Each switch is to be contained in a separate steel enclosure. The enclosure will employ a hinged cover for access to the fuses which will be interlocked with the operating handle to prevent opening the cover when the switch is in the "ON" position. This interlock shall be constructed so that it can be released with a standard electrician's tool for testing fuses without interrupting service. The units shall have padlocking provisions in the "OFF" position and the operating handle position shall give positive switch position indication, i.e.: red for "ON" and black for "OFF". Switches shall pass industry standard I2t withstand ability tests and fuse tests as described elsewhere in the specifications.

F. FUSIBLE SWITCHES (800-1200 AMPERES)

The branch switch shall be Square D Type AV and shall be fusible. When equipped with NEMA Class L fuses, these switches are suitable for use on systems with fault capacity of (100,000 amperes at 240 VAC) (200,000 amperes at 600 VAC). Switches shall be equipped with front operated, quick-make, quick-break operators. The switches shall be of the knife-switch blade type. Multiple plated type arc-quenchers and replaceable high temperature melting alloy arc-tops are supplied on the 600 volt versions of the switch. Phase barriers are made of flame-retardant, glass-polyester material. All current-carrying parts shall be of high-conductivity copper which is silver plated. A mechanical interlock shall be provided to prevent opening the compartment door or fuse access door when the switch is closed.

G. ARC ENERGY REDUCTION

Where fuses rated 1200A or higher are installed, provide arch flash mitigation documentation to those authorized to design, install, operated, or inspect the installation. Provide energy-reducing maintenance switching with local status indicator as means to reduce clearing time of the fuses.

PART 3 - EXECUTION

3.01 PANELS

- A. Provide labeling and complete typed directories.
- B. Tops not to exceed 72 " above floor.
- C. Provide lightning arrestors on panelboard.
- D. Provide laminated black phenolic resin with white core with 3/16 inch high engraved lettered nameplates for each switch to indicate the feeder, panelboards and equipment served. Mounted, with plated screws, adjacent to or on front of the switch.

3.02 GROUNDING

- A. Panels shall be grounded to a driven ground rod or other suitable ground.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 26 00 00 for additional requirements of this section.
- B. Refer to requirements of the NFPA 70 National Electrical Code, UL, and the NFPA.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to furnish and install panelboards as specified.

1.03 SUBMITTALS

- A. Submit manufacturers shop drawings of all equipment specified in this section.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturers' warranty requirements.

PART 2 - PRODUCTS

2.01 DISTRIBUTION PANELBOARDS (MDP or PP)

- A. **GENERAL** - Furnish and install distribution and power panelboards as indicated in the panelboard schedule and where shown on the plans. Panelboards shall be equipped with thermal-magnetic, molded case circuit breakers of frame and trip ratings as shown on the schedule.
- B. **BUSSING ASSEMBLY AND TEMPERATURE RISE** - Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Bus shall be plated copper.
- C. **CIRCUIT BREAKERS** - Circuit breakers shall be equipped with individually insulated, braced, and protected connectors. Circuit breakers shall be flush with each other. Tripped indication shall be clearly shown. Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. Mechanical lugs are to be copper. For 480-volt applications over 1000 Amp, the main breaker is to include electronic trip with LSIG characteristics.
- D. **** EQUIPMENT SHORT CIRCUIT RATING (FULLY RATED)** - Each panelboard shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or on the plans. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

- E. ARC ENERGY REDUCTION - Where circuit breakers rated 1200 Amp or higher are installed, provide arc flash mitigation documentation to those authorized to design, install, operated, or inspect the installation. Provide energy-reducing maintenance switching with local status indicator as means to reduce clearing time of the fuses or the breakers.
- F. CABINET - Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets to be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. End walls shall be removable. Fronts shall be of code gauge steel. Baked enamel finish electro-deposited over cleaned phosphatized steel.
- G. SAFETY BARRIERS - The panelboard interior assembly shall be dead front with panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers.
- H. UL LISTING - Panelboards shall be listed by Underwriters Laboratories and shall bear the UL label. When required, panelboards shall be suitable for use as service equipment.
- I. NAMEPLATES - Provide laminated black phenolic resin with white core with 3/16" high engraved lettered nameplates for each circuit breaker to indicate the feeder, panelboard and equipment served. Mounted, with plated screws, adjacent to or on front of the breaker.
- J. Panelboards shall be by Square D, Siemens, Cutler Hammer or ABB Group.

2.02 LIGHTING & RECEPTACLE PANELS (LP or RP)

- A. GENERAL - Furnish and install circuit breaker lighting panelboards as indicated in the panelboard schedule and where shown on the plans. Panelboards shall be equipped with thermal-magnetic molded case circuit breakers with frame and trip ratings as shown on the schedule.
- B. CIRCUIT BREAKERS - Shall be quick-make, quick-break, thermal-magnetic, trip indicating and have common trip on all multipole breakers. Trip indication shall be clearly shown by the breaker handle taking position between "ON" and "OFF" when the breaker is tripped. Branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than ten times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Single pole 15 and 20 Amp circuit breakers shall be UL listed as "Switching Breakers" at 120-volt AC and carry the SWD marking. UL Class A ground fault circuit protection shall be provided on 120-volt AC branch circuits as specified on the plans or panelboard schedule. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. A single pole circuit breaker with integral ground fault circuit interruption shall require no more panelboard branch circuit space than a conventional circuit breaker. A UL listed combination arc fault circuit interrupter (AFCI) shall be provided for all 120-volt, 15 or 20 Amp branch circuits as indicated on the plans or panelboard schedule or as required by the National Electrical Code. This protection shall be an integral part of the branch circuit breaker which also provides overload and short circuit protection for the branch circuit wiring. This breaker shall require no more panelboard branch circuit space than a conventional circuit breaker. Connections to the bus shall bolt-on.
- C. PANELBOARD BUS ASSEMBLY - Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single phase, three-wire panelboard bussing shall be such that any two adjacent single pole breakers are connected to opposite polarities in such a manner that two pole breakers can be installed in any location. Three phase, four-wire bussing shall be such that any three adjacent single pole breakers are

individually connected to each of the three different phases in such a manner that two or three pole breakers can be installed at any location. All current carrying parts of the bus assemble shall be plated copper. Main ratings shall be shown in the panelboard schedule or on the plans.

- D. WIRING TERMINALS - Terminals for feeder conductors to the panelboard mains and neutral shall be UL listed as suitable for the type of conductor specified. Terminals for branch circuit wiring, both breaker and neutral, shall be UL listed as suitable for the type of conductor specified.
- E. CABINETS AND FRONTS - The panelboard bus assemble shall be enclosed in a steel cabinet. The size of the wiring gutters and gauge of steel shall be in accordance with NEMA and UL Standards. The box shall be fabricated from galvanized steel or equivalent rust resistant steel.
Fronts shall include doors and have flush, cylinder tumbler-type locks with catches and spring- loaded stainless steel door pulls. Doors shall be mounted with completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door. Fronts shall be of code gauge steel.
- F. ** EQUIPMENT SHORT CIRCUIT RATING (FULLY RATED) - Each panelboard shall have a short circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or on the plans. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.
- G. UL LISTING - Panelboards shall be listed by Underwriters Laboratories and bear the UL label. Equal panelboards may be provided by Square D, G.E., Cutler Hammer, or Siemens.
- H. ELECTRONIC GRADE - Panels indicated to be electronic grade to have 200% rated neutrals, and an isolated ground bar in addition to the equipment ground bar.

PART 3 - EXECUTION

3.01 PANELS

- A. Panelboards are to be mounted in accordance with National Electrical Code Article 240.24 unless noted otherwise.
- B. Provide labeling and complete, typed directories.
- C. Ductwork or piping shall not pass over panels.
- D. Space shall be clear 3'-0" in front of panel floor to structural slab or roof above.
- E. All conduit entering the panel shall have a screwed hub with an insulated bushing and no sharp
- F. edges.
 - 1. Wires shall be labeled and neatly arranged in the wiring gutters with wires cut to proper lengths and neatly racked.
- G. Electronic grade panels shall have feeder neutrals rated at 200% to maintain the UL listing of the panel and be provided with isolated ground conductor back to service entrance or feeder transformer.

3.02 GROUNDING

- A. All panels shall be grounded to the building equipment grounding system per National

Electrical Code Article 408.40. Ground resistance shall not exceed the National Electrical Code values.

END OF SECTION

SECTION 26 27 00 - BASIC MATERIALS AND EQUIPMENT FOR METAL RACEWAY SYSTEMS

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 26 00 00 for additional requirements of this section.
- B. Refer to NEC 1-2000 for general installation requirements.

1.02 SUBMITTALS

- A. Submit shop drawings and manufacturer's catalog sheets of all specified items unless waived by the engineer.
- B. Submit switches and receptacles as a minimum.

PART 2 - PRODUCTS

2.01 RIGID METAL CONDUIT (GRS)

- A. Material; Steel, Zinc coated Federal Specification WW-C-581d, ANSI C801.
- B. Fittings; Malleable iron, Threaded
- C. NEC; Article 344
- D. Application; Indoor, above ground, enamel coated, all occupancies not subject to severe corrosive influences.
- E. Manufacturer; Hubbell, Allied Tube and Conduit Corp. or approved equal.

2.02 ELECTRICAL METALLIC TUBING (EMT)

- A. Material; Galvanized steel, U.L. labeled, Federal Specification ANSI C80.3.
- B. Fittings; Threadless compression type for up to 1-1/4", set screw for 1-1/2" and larger. Installation in accordance with Article 358 of the National Electrical Code and U.L. general information card #FJMX.
- C. NEC; Article 358
- D. Application; Exposed and concealed work not subject to physical damage.
- E. Manufacturer; Hubbell, Allied Tube and Conduit Corp. or approved equal.

2.03 FLEXIBLE METAL TUBING (FMT)

- A. Material; Hot dipped galvanized interlocking convolutions of steel tape in circular cross section. Federal Specification AA-55810
- B. Fittings; Hot dipped galvanized steel
- C. NEC; Article 344
- D. Application; All areas other than wet locations, hoistways, hazardous locations, below ground, and areas with exposure to oil, gasoline, or other materials having an adverse effect on rubber.

- E. Manufacturer; Electri-flex Company Liqueflex Type BR, Hubbell, Allied Tube and Conduit Corp., AFC.

2.04 RIGID NON-METALLIC CONDUIT (SCHEDULE 40 PVC)

- A. Material; U.L. 651, ANSI/ NEMA TC-2, Federal Military Specification WC-1094A, 90 °C wire rated and sunlight resistant.
- B. Fittings; PVC, same as above.
- C. NEC; Article 352
- D. Application; In walls, floors, ceilings, wet locations, underground, and locations subject to severe corrosive influences.
- E. Manufacturer; Carlon Schedule 40 electrical conduit or approved equal.

2.05 LIQUATITE FLEXIBLE METAL CONDUIT

- A. Material: Hot dipped galvanized interlocking convolutions of steel tape in circular cross section with PVC jacket.
- B. Fittings: Hot dipped galvanized steel.
- C. NEC Article 350 (LFMC)
- D. Application: All areas other than elevator hoistways, hazardous locations and where subject to physical damage.
- E. Manufacturers: Electriflex Company Liqueflex Type LT, Hubbell, Allied Tube and Conduit Corp., AFC.

2.06 CONDUCTORS

- A. Type; THHN, 98% conductivity copper, 600-volt, dry locations. Type THWN for wet locations. Conductors shall be U.L. listed.
- B. Equipment terminations for circuits rated 100 Amps or less (#14 AWG - #2 AWG) shall be rated 60 °C (140 °F). Equipment termination for circuits rated over 100 Amps (#1 or larger) shall be rated 75 °C (167 °F). Refer to NEC for allowable exceptions. 90 °C (194 °F) rated conductors shall be used as indicated on the drawings or as indicated within these specifications.
- C. Solid copper conductors for #10 and #12 wire size. #8 and larger are to be stranded copper.
- D. Separate green ground conductor for all circuits including branch, homerun, and feeders.
- E. All conductors shall be color coded as follows:
 - 120/ 208 Volt Systems
 - Phase A Black
 - Phase B Red
 - Phase C Blue
 - Neutral Grey or Natural White
 - 277/ 480 Volt Systems
 - Phase A Brown
 - Phase B Orange
 - Phase C Yellow
 - Neutral Grey or Natural White
- F. Minimum size conductor shall be #12 AWG except that #14 AWG shall be used for control wiring. All circuit conductors shall be run in the same raceway system.
- G. A grounding conductor shall be provided to each electrical device in accordance with the National Electrical Code.
- H. Conductor sizes are to be as indicated on the drawings and/ or as specified in this specification.
- I. Conductors are not to be installed in raceways until construction is advanced to allow conductors to

be installed completely without damage to conductors and there is not possibility of water or other contaminants entering the raceway system. Conductors shall be installed between convenient terminating points.

J. An approved pulling compound shall be used to assist in pulling of conductors.

K. Aluminum Alloy Conductors for Distribution Feeder Applications:

1. Distribution feeder conductor's sizes #6 AWG to 1000 Kcmil may be copper (Base Bid) or aluminum alloy (Alternate). Aluminum alloy conductors are to be compact standard conductors of a recognizable Aluminum Association 8000 Series aluminum alloy conductor material (AA-8000 series alloy). AA-8000 series alloy conductor must be Alcan Cable Stabiloy or approved equal.
2. Compliance with the elongation requirement per Table 10.1 of UL Standard 1581 for stranded AA-8000 series aluminum alloy conductors shall be determined on wires taken from the conductor after stranding by manufacturer.
3. Insulation:
 - a. For use in raceways: Type XHHW-2, temperature rating 90°C.
 - b. For use in cable trays: Sizes #1/0 AEG and larger. Type XHHW-2, temperature rating 90°C and marked: "SUN RES", "VW-1", "GASOLINE AND OIL-RESISTANT II", "FOR CT USE".

L. Manufacturers: Alpha Wire, Southwire, Tamaqua Cable, Triangle Wire & Cable, American Insulated Wire, BICC or General Cable.

2.07 FIRE PUMP CABLE SYSTEM

A. Type: RHH, 98% conductivity copper, 600-volt, dry location. Type RHW-2 for wet location. UL Listed conductors with 2-hour fire rating.

B. All conductors shall be color coded as follows:

120/ 208 Volt Systems

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	Grey or Natural White

277/ 480 Volt Systems

Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	Grey or Natural White

C. Conductors are not to be installed in raceways until construction is advanced to allow conductors to be installed completely without damage to conductors and there is not possibility of water or other contaminants entering the raceway system. Conductors shall be installed between convenient terminating points.

D. An approved pulling compound shall be used to assist in pulling of conductors.

E. Manufacturers: Draka Cableteq USA "Life Line Cables" or approved equivalent.

2.08 JUNCTION BOXES

A. Material; Galvanized steel, accessible.

B. Manufacturers; Keystone, Hubbell, Penn Panel and Box Co.

C. NEC; Article 314

2.09 OUTLET AND SWITCH BOXES

- A. Material; Galvanized steel with knockouts to suit raceway system.
- B. Manufacturer; Crouse Hinds Co., Steel City Div., Raco Inc., or approved equal.

2.10 WALL PLATES - METAL- COMMERCIAL SPECIFICATION GRADE

- A. Wall plates shall be standard size, metal, commercial grade.
- B. Plates shall be provided for all switches, receptacles, blanks, telephone, and special purpose outlets.
- C. Plates must be of modern design having rounded edges and corners and be complete with color-matched mounting screws.
- D. Plates must be of one design throughout the building and shall conform to UL, CSA, and NEMA standards.
- E. Engraving shall be done by plate manufacturer in accordance with the schedule.
- F. Acceptable Manufacturers: Cooper Wiring Devices, Pass & Seymour, Hubbell, Leviton.

2.11 WALL PLATES - STAINLESS STEEL - TYPE 302 - CORROSIVE/ DAMPNES/ FOOD SERVICE DUTY

- A. Wall plates shall be Pass and Seymour Sierra Series "S", Type 430 Stainless Steel, or "S-N" line Type 302 Stainless Steel or equal and will conform to UL and NEMA standards.
- B. Plates must be provided for all switches, receptacles, blanks, telephone and special purpose outlets.
- C. Plates shall be of a modern design, having rounded edges and corners and be complete with finish-matching mounting screws.
- D. Engraving shall be done by plate manufacturer in accordance with the schedule.
- E. Plates must be of one design throughout the building.
- F. Acceptable Manufacturers: Cooper Wiring Devices, Pass & Seymour, Hubbell, and Leviton.

2.12 RECEPTACLES - STANDARD DUTY - COMMERCIAL/ SPECIFICATION GRADE

- A. All thermoplastic nylon body construction.
- B. Impact-resistant nylon face.
- C. One-piece triple-wire brass power contact.
- D. Available with side and back wire capable of accepting #14 - #10 AWG copper or copper-clad wire.
- E. Terminal compartments isolated from each other for positive conductor containment.
- F. Automatic grounding clip assures grounding to metallic boxes.
- G. Easily accessible break off tabs to facilitate split circuit wiring.
- H. Plated steel strap for corrosion resistance.
- I. Combination Phillips/ slotted head screws backed out for ease of installation.
- J. In compliance with UL 498.
- K. Pre-wired pigtail connectors that accommodate Federal Specification Receptacles are approved. Must be crimped and welded terminal right angle application within the connector.
- L. Receptacle shall be Federal Specification, WC896 compliant. Marking should be clearly identifiable on face or strap.
- M. Acceptable Manufacturers: Cooper Wiring Devices, Pass & Seymour, Hubbell, and Leviton.
- N. Leviton 5362/ 5361, 20 Amp, ivory, white, grey, black, brown or almond.

2.13 RECEPTACLES - DECORA - SPECIFICATION GRADE

- A. Impact-resistant nylon face.
- B. One-piece, triple-wire brass power contacts.
- C. Corrosion resistant, plated, wrap-around steel strap locked into assembly to prohibit strap from bending away from body.

- D. Terminal compartments isolated from each other for positive conductor containment.
- E. Available in hospital grade & specification grade.
- F. Heavy-duty compact design for easier installation and long-lasting performance.
- G. Automatic grounding clip standard for positive ground to metal boxes.
- H. All devices fit standard #26 opening wall plate.
- I. Side and back wire accepts #14 - #10 AWG.
- J. In compliance with UL 498.
- K. Pre-wired pigtail connectors that accommodate Federal Specification Receptacles are approved. Must be crimped and welded terminal right angle application within the connector.
- L. Receptacle shall be Federal Specification, WC896 compliant. Marking should be clearly identifiable on face or strap.
- M. Acceptable manufacturers: Cooper Wiring Devices, Pass & Seymour, Hubbell, and Leviton.
- N. Leviton 16352, 20 Amp, white, ivory, grey, black, or almond.

* Those receptacles installed on the emergency system shall be clearly identifiable as distinct from normal system receptacles. (Red)

2.14 GROUND FAULT CIRCUIT INTERRUPTING RECEPTACLES - STANDARD GRADE

- A. Side or screw pressure plate back wire with #14 or #12 AWG solid or y-stranded copper wire.
- B. Extra-long strap.
- C. High-impact resistant thermoplastic construction.
- D. Ground screw with a wire guide channel.
- E. Dual-direction test and reset buttons.
- F. Line and load terminations supplied backed out, and ready to wire.
- G. Two back wire holes per terminal.
- H. Ultrasonic welding of face to back body.
- I. Mis-wire label applied to load terminals.
- J. GFCI receptacle are to have SafeLock protection. If critical components are damaged and ground fault protection is lost or if mis-wired, power to receptacle is disconnected.
- K. Class A rated GFCI
- L. 1-1/2 HP rating on Motor Control GFCI switch (2081 series).
- M. Button colors match the device face.
- N. Supplied with matching wall plate.
- O. In compliance with UL-943, UL-498, UL-508.
- P. Pre-wired pigtail connectors that accommodate Federal Specification receptacles are approved. Must be crimped and welded terminal right angle application within the connector.
- Q. Receptacle shall be Federal Specification, WC896 compliant. Marking should be clearly identifiable on face or strap.
- R. Acceptable Manufacturers: Cooper Wiring Devices, Pass & Seymour, Hubbell, and Leviton.
- S. Leviton 6898, 20 Amp, ivory, white, almond, or mahogany.

2.15 TAMPER RESISTANT RECEPTACLES - COMMERCIAL

- A. Thermoplastic shutter for reliable tamper-resistant design.
- B. High-impact thermoplastic face and body.
- C. One-piece Brass Alloy grounding system.
- D. High performance copper alloy contacts assure the highest degree of blade retention.
- E. Ground contacts are encapsulated in thermoplastic body.
- F. Side or back wiring accepts #10, #12 or #14 AWG copper.
- G. Eight hold back wiring for convenient feed thru wiring.

- H. In compliance with UL-498.
- I. Pre-wired pigtail connectors that accommodate Federal Specification receptacles are approved. Must be crimped and welded terminal right angle application within the connector.
- J. Receptacle shall be Federal Specification, WC896 compliant. Marking should be clearly identifiable on face or strap.
- K. Acceptable manufacturers: Cooper Wiring Devices, Pass & Seymour, Hubbell, and Leviton.
- L. Leviton 8300-SG, 20 Amp, ivory, white, grey, red or brown.

2.16 RECEPTACLES - FLOOR OUTLET

- A. Solid brass covered plate with matching flush fitting brass cap.
- B. Receptacle made of durable thermoplastic.
- C. Supplied with foam rubber gasket. O-ring and metal, 18" cubic box.
- D. In compliance with UL 498.
- E. Pre-wired pigtail connectors that accommodate Federal Specification receptacles are approved. Must be crimped and welded terminal right angle application within the connector.
- F. Receptacle shall be Federal Specification, WC896 compliant. Marking should be clearly identifiable on face or strap.
- G. Acceptable manufacturers: Cooper Wiring Devices, Pass & Seymour, Hubbell, and Leviton.
- H. Leviton 5362/ 5361, 20 Amp, ivory, white, grey, black, brown, or almond.

2.17 TOGGLE SWITCHES - COMMERCIAL DUTY SPECIFICATION GRADE

- A. One-piece brass alloy contact arm.
- B. Thermoset body and cover for superior heat resistance.
- C. High strength polycarbonate toggle resists breaking and chipping under heavy abuse.
- D. Available with side wire or side and back wire models capable of accepting #14 - #10 AWG copper or copper-clad wire.
- E. Cam designed for fast make with positive break action to minimize arcing and prolong switch life.
- F. Heavy-duty toggle bumpers for smooth and quiet operation.
- G. Oversized silver alloy contacts for longer dependable switch life.
- H. Plated steel strap for corrosion resistance.
- I. Combination Phillips/ slotted head screws backed out for ease of installation.
- J. In compliance with UL 20.
- K. Switches shall be Federal Specification WC596 compliant. Marking should be clearly identifiable on face or strap.
- L. Acceptable Manufacturers: Cooper Wiring Devices, Pass & Seymour, Hubbell, and Leviton.
- M. Leviton CS120-2/ CS320-2/ CS420-2, 20 Amp, 120/ 277 V, ivory, white, black, grey, or almond.

2.18 AC MOTOR RATED SWITCH

- A. 30 Amp and/ or 40 Amp, 600 V AC rated.
- B. Double-pole or triple-pole, single-throw.
- C. UL 508, UL 94 (flammability) Listed.
- D. All molded parts are made of thermoplastic material to assure superior resistance to repeated impact, chemical degradation, extreme temperature fluctuations, tracking and arcing.
- E. Positive-contact design enhances fast make/ slow break mechanism by minimizing bounce and arcing upon contact closure and teasing upon separation.
- F. Free-travel toggle design protects closed contacts from accidental disengagement and contact teasing.
- G. Silver alloy contacts provide maximum conductivity and prolonged service life.

- H. Side and back wire terminal screws accept up to #10 AWG solid copper wire.
- I. For standard #8 AWG wire, remove terminal clamp and use ring terminal.
- J. Oversized #10, triple-combination, vibration-resistant terminal screws.
- K. Mounting yoke is made from nickel-plated brass for superior corrosion resistance.
- L. Insulating barriers between terminal screws provide isolation from each phase.
- M. Devices are permanently marked with catalog number, Amperage, voltage, and horse-power ratings to assist with identification.
- N. Large toggle provides positive actuation, even when operated with gloved hand.
- O. Leviton MS302 (30 Amp, 2-Pole), MS 303 (30 Amp, 3-Pole), MS402 (40 Amp, 2-Pole) or MS403 (40 Amp, 3-Pole) or equivalent by Cooper Wiring Devices, Hubbell or Pass & Seymour.

2.19 DIMMER SWITCHES - DECORA SLIDE TYPE- SPECIFICATION GRADE

- A. Maximum ratings are for continuous full load.
- B. RFI suppression built in.
- C. Extra-heavy use models supplied with matching cover.
- D. Leviton 80800/ 80800-3/ 81000/ 81000-3/ 82000/ 82000-3, 800 watt, 1,000 watt, 2,000 watt - 120V, 277V.
- E. Acceptable manufacturers: Cooper Wiring Devices, Pass & Seymour (Titan Series), Hubbell, Leviton.
- F. Full on bypass.
- G. Ivory, white, or grey.
- H. Pre-set on-off switch.

2.20 SURFACE METAL RACEWAY AND WIREWAY

- A. Provide surface metal raceway system complete with all fittings, wiring, devices, etc. Surface raceway are to have baked enamel finish.
- B. These raceways are permitted only in dry locations where not subject to severe physical damage and must have metal not less than .04" thick. Do not use in hoistways and in any hazardous classified areas.
- C. The number, type, and size of conductors permitted in raceway are to be clearly marked on raceway or on shipping label.
- D. Splices and taps may be made providing raceway has an accessible removable cover.
- E. Wireway made of 14-gauge sheet metal forming a square trough with hinged cover and complete with couplings, 90° elbows, tees, junction boxes, end plates, and supports may be used for surface wiring at load centers and other locations to the extent permitted by the NEC.
- F. Wireways in sizes 2-1/2" x 2-1/2" up to 12" x 12" square may be used; however, no conductor larger than that which the wireway is designed is to be installed therein. Wireway is to not contain more than 30 current carrying conductors at any cross-section and the sum of cross-sectional areas of all contained conductors at any cross-section is to not exceed 20% of the interior cross-sectional area of wireway.
- G. Wireways are to be treated with rust resistant primer and finished with gray, baked enamel.

2.21 MC CABLE

- A. Type; UL listed Type MC Cable with galvanized steel armor outer casing, color coded circuit conductors, insulated green grounding conductor. Each conductor insulated with thermoplastic insulation.
- B. NEC; Article 330, 518 and to comply with Federal Specification J-C-30B.
- C. Manufacturers: AFC Cable Systems MC, Alean Cable, BICC, Tamaqua Cable.

2.22 FIRE ALARM MC CABLE

- A. Type; UL listed Type MC Cable with galvanized steel armor outer casing, bare grounding conductor, color-coded circuit conductors. Each conductor insulated with thermoplastic insulation.
- B. NEC; Article 760 and to comply with Federal Specification J-C-30B.
- C. Manufacturer: AFC Cable Systems Fire Alarm Cable or approved equal.

2.23 SECURITY PLATES

- A. Receptacle, switch, telephone, and GFCI plates in secure areas are to be made of minimum 14-gauge one piece die formed cold rolled steel.
- B. Baked white enamel finish, polyester powder, five-stage pre-treatment, 85% glass, minimum 2H hardness.
- C. Back plate 10-gauge prime galvanized steel with four threaded holes. Security screws Torx T-20.
- D. U.L. Listed.
- E. Manufacturers: Hubbell.

2.24 RECESSED FLOOR BOX (CONCRETE FLOOR)

- A. One, two, or three gang box, cast iron for on or below grade, stamped steel for above grade.
- B. Fully adjustable before and after concrete pour.
- C. Shallow box as necessary.
- D. Removable dividers as necessary for multi-service applications.
- E. One, two, or three gang cover plates; Carpet, tile, or brass as per application.
- F. Walker Wiremold Omnibox Multiservice Floor Box series.
- G. Acceptable Manufacturers: Wiremold, Hubbell, Thomas & Betts, Crouse Hinds.

2.25 MULTI-SERVICE FLUSH POKE-THRU (4" FLOOR CORE)

- A. Flush poke-thru with four Category 5 communications jacks and power.
- B. Communication adapter for protection of Category 5 cables.
- C. EMI/ RFI shielded divider, UL recognized.
- D. Manufacturers furnish 20 Amp isolated grounding specification grade duplex receptacle.
- E. 2-hour fire rating, UL Listed.
- F. Grommets for unused data jack parts (coordinate with data communications contractor).
- G. Wiremold RC2001 Category 5 Flush Poke-thru.
- H. Acceptable Manufacturers: Wiremold, Hubbell, Thomas & Betts, approved equivalent.

2.26 3 SERVICE FURNITURE FEED POKE-THRU (3" FLOOR CORE)

- A. Flush poke-thru for telephone, data, and power (up to 10 wire) feeds to furniture partitions.
- B. Communication adapter for protection of communications cables.
- C. Up to 4-hour UL Listed fire rating as indicated on drawings or specifications.
- D. Wiremold RC700 - 6A series flush poke-thru.
- E. Acceptable manufacturers: Wiremold, Hubbell, Thomas & Betts.

2.27 MULTI SERVICE WALL SOURCE BOX

- A. The new construction box system is to be the WallSource Multi Service Box as manufactured by the Wiremold Company, or approved equivalent.

1. (Two) (Three) or (Four) gang box. The box and all system components are to be UL listed in full compliance with the standard for 514A and 514C; steel shall be galvanized with a minimum wall thickness of .063" throughout. Backfeed brackets shall be .050" minimum steel with a gray or ivory, suitable for field painting. The device mounting bracket is to be molded from color matching UL approved resins.
 2. The box shall include the box, dividers, and mounting brackets. The dimensions of each is to be a minimum of 32 cubic inches per gang and shall be manufactured of 16 gauge minimum thick steel. The box is to accommodate standard power and communication devices.
 3. The box is to have knockouts located on top and bottom, 2-1/4" from the face to accommodate combinations of 1/2"Ø, 3/4"Ø and 1"Ø trade size conduits.
 4. The box is to have a separate ground terminal provided for each gang.
 5. The box is to adjust for a flush installation with the finished wall.
- B. Device Mounting. The self-leveling device mounting bracket is to accommodate standard power devices, Interlink Activate connectivity inserts, and Wiremold 5507 Series faceplates. A mounting bracket designed to accept other manufacturer's devices is to be available. The bracket accommodates up to four power devices or 12 communications inserts. All Wiremold standard faceplates, mounting brackets and trim rings are to be color matched.
- C. Fiber Optic/ Category 5 Radius. The depth of the box shall accommodate a 1-1/4" cable bend radius which meets or exceeds the specifications for fiber Optic and Category 5 cabling and TIA/ EIA - 569A requirements for communications pathways.
- D. Device Covers. Device cover plates in the following configurations are to be available: duplex device cover plates, single 1.40" and 1.59"Ø receptacle cover plates, switch plates, GFCI cover plates, Sentrex surge receptacle cover plates and other rectangular faced plates. Single-gang cover plates are to be of modular design and are to be compatible with wire and cable management systems.
- E. Communication Devices and Accessories. The box manufacturer is to provide a complete line of connectivity outlets and modular multi-media inserts for voice, data, video, audio, etc. with faceplates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons and write-on station identification labels are to be available.
- F. Support Bracket. A support bracket for mounting on 16" center studs is to be provided on boxes more than two-gang.
- G. Dividers. Dividers are to be removable without any tools.

2.28 MULTISERVICE RECESSED WALL BOX (FLAT SCREEN TVs, MONITORS)

- A. Three gang box, plastic housing, white finish. Flush mount appearance allows for snug-to-wall placement of flat-screen TV or monitor.
- B. Surge-protective duplex power outlet and up to 12 multimedia connections.
- C. Position either line voltage or low voltage devices in all three openings.
- D. Low voltage connectors offer both terminated and pull-through capability so plugs, and multimedia connections stay recessed behind the surface of the wall.
- E. Accepts standard TP wall plate.
- F. Legrand TV3WTVSSW. (ACTS standard)
- G. Acceptable Manufacturers: Hubbell, Thomas & Betts.

2.29 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Hubbell Lighting.
 2. Leviton Mfg. Company Inc.
 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 4. Novitas, Inc.

5. RAB Lighting, Inc.
 6. Sensor Switch, Inc.
 7. TORK.
 8. Watt Stopper (The).
 9. Pass & Seymour
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
1. Operation: Unless otherwise indicated, turn luminaires on when covered area is occupied and off when unoccupied; with a time-delay for turning luminaires off, adjustable over a minimum range of one to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20 Amp ballast load at 120- and 277-V AC, for 13 Amp tungsten at 120 V AC, and for 1 HP at 120 V AC. Power supply to sensor shall be 24 VDC, 150 mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2" knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to indicate when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 - 200 FC; keep luminaires off when selected illuminance level is present.
- C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 0'-6" minimum movement of any portion of a human body that presents a target of not less than 3'-0" square feet.
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1,000 square feet when mounted on an 8'-0" high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90'-0" when mounted on a 10'-0" high ceiling.
- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 1'-0" in either a horizontal or a vertical manner at an approximate speed of 1'-0" per second.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 square feet when mounted on an 8'-0" high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1,000 square feet when mounted on an 8'-0" high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2,000 square feet when mounted on an 8'-0" high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90'-0" when mounted on a 10'-0" high ceiling in a corridor not wider than 14'-0".
- E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. A particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 0'-6" minimum movement of any portion of a human body that presents a target of not less than 3'-0" square feet and detect a person of

- average size and weight moving not less than 1'-0" in either a horizontal or a vertical manner at an approximate speed of 1'-0" per second.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1,000 square feet when mounted on an 8'-0" high ceiling.

PART 3 - EXECUTION

3.01 WIRING DEVICES

- A. Lighting outlet boxes to have 3/8" fixture studs.
- B. Exterior boxes shall be gasketed and watertight.
- C. Switch and device plates to be mounted with all four corners touching adjacent surface.
- D. All devices to be installed true and plumb.
- E. Switch plates and receptacles shall not be placed back-to-back in adjacent rooms. Offset locations a minimum of 0'-3" to restrict noise transfer. This shall also apply to TV outlets, telephone outlets, data outlets.
- F. All devices on opposite side of a fire resistance rated wall assembly are to be separated by a horizontal distance of not less than 2'-0".
- G. Ground-fault circuit-interrupters are to be provided on all outdoor receptacle circuits, receptacle circuits within toilet and bathrooms, areas in close proximity to water, and wherever else indicated on the drawings or required by Code. While-in-use type covers are to be used in exterior wet locations.
- H. Tamper resistant receptacles are to be installed in day care areas, pediatric health care, psychiatric care as well as where indicated on the drawings. Refer to NEC 406.12 and 517.18 (C).
- I. Arc-fault circuit-interrupters shall be provided on all 15 Amp and 20 Amp receptacle branch circuits in dwelling unit bedrooms.
- J. Dimmer switch devices shall be appropriately sized for derating when a minimum of two or more are ganged together in a common wall box.

3.02 WIRING METHODS

- A. Exposed interior wiring, panel feeders, home runs, equipment feeders; EMT. EMT conduit shall be securely fastened at intervals not exceeding 10'-0" and within 3'-0" of all boxes. NOTE: Exposed means all wiring which is not installed within walls, above suspended ceilings, or within a pre-manufactured raceway. Any raceway that is to be exposed in a finished area is to be coordinated with the architect/ engineer prior to installation.
- B. Concealed branch circuiting above suspended ceilings, and in stud partitions; MC Cable. MC Cable shall be securely fastened at intervals not exceeding 4'-6", and within 1'-0" of all boxes or fittings. All home runs are to be in EMT.
- C. Wiring in concrete slabs or decks is not permitted unless approved by the architect or structural engineer.
- D. Exposed exterior wiring; Intermediate rigid conduit.
- E. Wiring below concrete slabs in earth; PVC conduit. Provide GRS conduit sweep elbow through concrete slab.
- F. Service wiring; PVC conduit encased in 0'-2" of reinforced concrete from utility transformer or pole to the building (below slab is not required to be encased).
- G. Concrete encasement; 0'-2" minimum cover around each conduit requiring encasement. Reinforcement consisting of 4" x 4" No. 4 wire mesh on top level of conduit.
- H. Emergency feeder from generator set (if outside building) to building; PVC conduit encased in 0'-2"

of concrete, IMC within building.

- I. Minimum conduit size is 3/4"Ø.
- J. Flexible connections to all motors. Maximum length of flexible conduit is to be 3'-0".

3.03 RACEWAY SYSTEMS

- A. All secondary wiring is to be installed in rigid metal conduit, electrical metallic tubing, or MC Cable as specified in these Specifications.
- B. Electrical metallic tubing shall be employed in lieu of rigid metal conduit in all locations except:
 - 1. Underground
 - 2. In gravel, cinder, concrete, or other sub-base floor construction. PVC may be used under floor.
 - 3. Horizontal runs in concrete floor slabs. PVC may be used in slabs.
 - 4. Where subject to possible mechanical injury
 - 5. In masonry construction below finished grade. PVC may be used.
 - 6. Vertically in poured concrete walls.
 - 7. For service work
 - 8. For main distribution feeders
- C. All raceway components shall be fastened at intervals not exceeding 8'-0".
 - 1. Conduits shall not fasten or come in contact with piping of other trades as installed in this building.
 - 2. Conduit is to be separated by a distance not less than 0'-6" from any water, steam or gas lines as may be installed in the building.
- D. Conduits and raceway systems are not to be run concealed in walls, partitions, and floor slabs. Conduit which must be exposed is to be arranged as to not pass in front of windows, doors, access panels, access doors, sky lights, HVAC equipment access for coil removal or filter removal or required service clearances.
- E. Pulling fittings are to be provided for any conduit run which exceeds 200'-0 in length.
- F. All high voltage conduits (all conduit serving equipment over 600-volts) are to be painted red and labeled "HIGH VOLTAGE" on 10'-0" intervals. This does not apply to conduit below grade.
- G. All exposed fire alarm conduits are to be painted red, unless directed otherwise by the architect. This is to include the 120-volt feed to the control panel. Junction boxes are to be labeled "FIRE ALARM."
- H. All emergency circuits (MC Cable and conduit) are to be painted red unless directed otherwise by the architect. Junction boxes are to be labeled "EMERGENCY XXXV." Appropriate voltage is to be indicated.
- I. All conduits and raceway components installed under this Section for completion by others are to be provided with a pull wire affixed at both ends of conduit.
- J. Insulating bushings are to be used on all conduit terminations entering enclosures, boxes, and panels to protect the conductor from damage during installation.

3.04 POWER WIRING

- A. Wire between motors, starters, disconnects and source.
- B. Verify proper motor rotation. Check for smooth operation.
- C. Furnish and install weatherproof disconnects, as indicated.
- D. All panel feeders are to be run in EMT raceway system.
- E. All wiring to roof top units, fans, and HVAC units is to be completely installed between panel, disconnect switches and motor or unit connections.
- F. Disconnects are to be mounted adjacent to electrical and mechanical equipment. Indoor installations are to utilize NEMA 1 enclosures. Outdoor installations are to utilize NEMA 3R enclosures.

3.05 GROUNDING

- A. All electrical equipment and systems are to be grounded.
- B. Grounding system is to consist of a ground bus bar connected to a driven ground rod. Utilize ground type clamp fitting.
- C. All connections to conduit, equipment and devices are to be made with compression type connections.
- D. The grounding system is to comply with the NEC.
- E. All outside luminaires and poles are to be grounded.
- F. All equipment and devices are to be grounded in accordance with the manufacturer's recommendations.
- G. The ground system is to have a resistance of 25 ohms or less in compliance with the NEC. Utilize the fall of point method.
- H. Furnish a ground system test report at the completion of the work.
- I. Substation area grounding is to be in accordance with local utility company standards.

END OF SECTION

SECTION 26 28 16 - SAFETY SWITCHES - HEAVY DUTY

- * **Industrial, commercial, all 480-volt applications.**

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to section 26 00 00 for requirements which are applicable to this section.
- B. Refer to NFPA and in particular the National Electrical Code.
- C. Refer to NEMA, UL, and IEEE Standards.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to furnish and install and place into operation safety switches where indicated on the drawings and specified herein.

1.03 SUBMITTALS

- A. Submit manufacturer's shop drawings of devices.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.
- B. Install systems and equipment in accordance with the National Electrical Code and local codes having jurisdiction.
- C. Provide adequate supervision of labor force to see that installations are correct.

PART 2 - PRODUCTS

2.01 HEAVY DUTY SAFETY SWITCHES

- A. APPLICATION DATA
 - 1. 30 Amp-1200 Amp
 - 2. 600-volts AC for 480-volt applications
 - 3. 240-volt AC for 240-volt and 208-volt applications.
 - 4. NEMA 1 - General Purpose, painted sheet steel
 - 5. NEMA 3R - Rainproof, painted galvanized steel
 - 6. Maximum - Time delay (dual element) fuse
- B. CONSTRUCTION
 - 1. Visible blades
 - 2. Handle attached to box, not cover
 - 3. Handle position indicates "ON" or "OFF"
 - 4. Top hinged cover on NEMA 3R

5. Operating mechanism is quick-make, quick-break
6. Plated current carrying parts
7. Provisions for padlocking the switch in the "OFF" position
8. Class R fuse standard for 30 Amp-600 Amp switches.
9. Class L fuses standard for 800Amp-1200 Amp switches.
- C. **NEUTRAL AND GROUNDING**
Provisions for field installation of solid neutral assembly.
Ground kits for field installation
- D. **TERMINALS**
UL listed for Al or Cu wires
UL listed for 60°C, or 75°C wires
Meets UL 486 B requirements
- E. **FUSE CLIPS**
Spring reinforced
Plated
- F. **APPLICATION**
Fusible - Class R or Class L as indicated above
Not fusible
- G. **NEMA STANDARDS**
KS1 - 1975
- H. **UL LISTING**
UL 98 Enclosed Switches
Maximum HP ratings
- I. **UL LISTED SHORT CIRCUIT RATING:**
200,000 RMS Symmetrical Amperes with proper rejection kit and Class R fuses.
- J. **Acceptable Manufacturers:**
 1. Siemens
 2. Cutler Hammer
 3. ABB Group.
 4. Square D

PART 3 - EXECUTION

3.01 SAFETY SWITCHES

- A. Furnish and install safety switches on all motors which do not have integral equipment disconnect devices, local starters and/ or where indicated on the drawings.
- B. Furnish and install safety switches where indicated on the drawings.
- C. Safety switches shall be installed to meet the area classification as to standard, hazardous, rainproof, etc.
- D. Safety switches shall be installed securely to building structure or be provided with supplemental support steel such as angle iron or uni-strut when required to locate on other than building structure.
- E. All safety switches shall be grounded.

END OF SECTION

SECTION 26 30 00 - EMERGENCY POWER SYSTEM (NATURAL GAS GENERATOR SET)

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 26 00 00 for requirements which are applicable to this section.
- B. Refer to the requirements of the National Electrical Code and ICC codes.
- C. Refer to NFPA codes, particularly Pamphlet 54 for requirements pertaining to the natural gas installation, and Pamphlet 101 and 110.
- D. Refer to NECA/ EGSA 404-2000 for general installation requirements.
- E. Refer to NFPA 99 for Health Care Facilities.

1.02 WORK INCLUDED

- A. Provide labor, material, equipment, and supervision necessary to install a complete (standby) (emergency) power system and wiring system for emergency power, emergency lighting, fire alarm system, nurse call, emergency heat, and communications.
- B. The system shall be complete with generator, engine, fuel system, ventilation system, exhaust system, (remote) monitoring control wiring from automatic transfer switches, both new and existing, and concrete pad.
- C. Provide labor, material, equipment, fuel, and supervision necessary to install a temporary portable diesel generator of similar size to maintain emergency power system during removal of existing generator and installation of new generator set.
- D. Provide code required signage (NEC 700.7, 701.7 and/ or 702.7).

1.03 SUBMITTALS

- A. Furnish shop drawings and manufacturers descriptive literature on all aspects of the (emergency) (standby) generator and the automatic transfer switch. Include physical data, wiring diagrams, electrical data, installation requirements, operating instructions, and fuel consumption.

1.04 QUALITY CONTROL

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MTU Onsite Energy
2. Caterpillar, Inc.
3. Kohler Co.
4. Cummins Power
5. Generac

2.02 ENGINE GENERATOR SET

- A. Furnish a coordinated assembly of compatible components.
- B. Output Connections: Three phase, four wire.
- C. Safety Standard: Comply with ASME B15.1.
- D. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identifies manufacturer of origin and address, and model and serial number of items.
- E. Limiting dimensions indicated for system components are not exceeded.
- F. Power Output Ratings: Nominal ratings as indicated, ____ KW with capacity as required to operate as a unit as evidenced by records of prototype testing.
- G. Skid: Adequate strength and rigidity to maintain alignment of mounted components without depending on a concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components.

2.03 GENERATOR-SET PERFORMANCE

- A. Steady-State Voltage Operational Bandwidth: 4% of rated output voltage from no load to full load.
- B. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
- C. Transient Voltage Performance: Not more than 20% variation for 50% step-load increase or decrease. Voltage recovers to remain within the steady-state operating band within three seconds.
- D. Steady-State Frequency Operational Bandwidth: 0.5% of rated frequency from no load to full load.
- E. Steady-State Frequency Stability: When the system is operating at any constant load within rated load, there are no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- F. Transient Frequency Performance: Less than 5% variation for a 50% step-load increase or decrease. Frequency recovers to remain within the steady-state operating band within five seconds.
- G. Output Waveform: At no load, harmonic content measured line to line or line to neutral does not exceed 5% total and 3% for single harmonics. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
- H. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, the system will supply a minimum of 250% of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.
- I. Start Time: Comply with NFPA 110, Type 10, system requirements.
- J. Air requirements: Maximum air required for combustion and cooling is to be as follows:

< 50 KW:	160 CFM/ KW
50 KW - 100 KW:	130 CFM/ KW
100 KW - 200 KW:	110 CFM/ KW

2.04 ENGINE

- A. Comply with NFPA 54.
- B. Fuel: Natural gas.
- C. Rated Engine Speed: 1800 rpm.
- D. Maximum Piston Speed for Two-Cycle Engines: 1725 fpm (8.8 m/ s).
- E. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/ s).
 - 1. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items are mounted on engine or skid:
 - a. Filter and Strainer: Rated to remove 90% of particles 5 micrometers and smaller while passing full flow.
 - b. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. The unit is capable of full flow and is designed to be fail-safe.
 - c. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps or siphons or special tools or appliances.
- F. Engine fuel system: System includes the following:
 - 1. Unit-mounted electric solenoid fuel shut-off valve.
 - 2. Flexible fuel line.
 - 3. Secondary fuel pressure regulator.
- G. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment.

2.05 GOVERNOR

- A. Type: Isochronous.

2.06 ENGINE COOLING SYSTEM

- A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator-set skid and integral engine-driven coolant pump.
- B. Radiator: Rated for specified coolant.
- C. Coolant: Solution of 50% ethylene-glycol-based antifreeze and 50% water, with anticorrosion additives as recommended by engine manufacturer.
- D. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
- E. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - 1. Rating: 50-psig (345-kPa) maximum working pressure with 180° F (82° C) coolant, and non-collapsible under vacuum.
 - 2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

2.07 ENGINE EXHAUST SYSTEM (MUFFLER ONLY BY ELECTRICAL CONTRACTOR)

- A. Muffler: Critical type, sized as recommended by engine manufacturer. Measured sound level at a distance of 10'-0" (3 m) from exhaust discharge is 85 dBA or less.
- B. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to muffler drain outlet through a petcock.
- C. Connections from Engine to Exhaust System: Flexible section of corrugated stainless-steel

- pipe.
- D. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.
 - E. Supports for Muffler and Exhaust Piping: Spring hangers and all-thread rods and vibration hangers attached to building structure.
 - F. Exhaust Piping External to Engine: ASTM A 53, Schedule 40, welded, black steel, with welded joints and fittings.
 - G. Exhaust piping insulation: 0'-4" high temperature calcium silicate with aluminum jacket.

2.08 STARTING SYSTEM

- A. Description: 12V or 24V electric, with negative ground and including the following items:
 - 1. Components: Sized so they will not be damaged during a full engine-cranking cycle.
 - 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 - 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 - 4. Battery: Adequate capacity within ambient temperature range.
 - 5. Battery Cable: Size as recommended by generator set manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 - 6. Battery Compartment: Factory fabricated metal with acid-resistant finish and thermal insulation. A thermostatically controlled heater is arranged to maintain battery above 10° C regardless of external ambient temperature. Include accessories required to support and fasten batteries in place.
 - 7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.
 - 8. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type. Unit complies with UL 1236 and includes the following features:
 - a. Operation: Equalizing-charging rate of 10 A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. The unit then automatically switches to a lower float-charging mode and continues operating in that mode until the battery is discharged again.
 - b. Automatic Temperature Compensation: Adjusts float and equalizes voltages for variations in ambient temperature from minus 40° C to plus 60° C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10%.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters indicate charging rates.
 - e. Safety Functions: Include sensing of abnormally low battery voltage arranged to close contacts providing low battery voltage indication on control and monitoring panel. Also include sensing of high battery voltage and loss of ac input or dc output of battery charger. Either condition closes contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.09 CONTROL AND MONITORING

- A. Functional Description: When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate

automatic-transfer switches initiate starting and stopping of the generator set. When the mode-selector switch is switched to the on position, the generator set manually starts. The off position of the same switch initiates generator-set shutdown. When the generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages are grouped on a common control and monitoring panel mounted on the generator set. The Mounting method isolates the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: Include the following:
 - 1. AC voltmeter.
 - 2. AC ammeter.
 - 3. AC frequency meter.
 - 4. DC voltmeter (alternator battery charging).
 - 5. Engine-coolant temperature gage.
 - 6. Engine lubricating-oil pressure gage.
 - 7. Running-time meter.
 - 8. Ammeter-voltmeter, phase-selector switch(es).
 - 9. Generator-voltage adjusting rheostat.
 - 10. Start-stop switch.
 - 11. Overspeed shutdown device.
 - 12. Coolant high-temperature shutdown device.
 - 13. Coolant low-level shutdown device.
 - 14. Oil low-pressure shutdown device.
 - 15. *Propane fuel tank derangement alarm, if applicable.
 - 16. *Propane fuel tank high-level shutdown of fuel supply alarm, if applicable.
 - 17. Generator overload.
- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
- E. Remote Emergency-Stop Switch: Flush wall-mounted, unless otherwise indicated and prominently labeled. Push button is protected from accidental operation.
- F. Remote Alarm Annunciator: Comply with NFPA 99. Labeled LEDs identify each alarm event. Common audible signal sounds for alarm conditions. The silencing switch in face of panel silences signal without altering visual indication, connect so that after alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface or flush-mounting type to suit mounting conditions indicated. Locate at Nurse's Station as shown on drawings or as required by NFPA.

2.10 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100% rated; complying with NEMA AB 1 and UL 489.
 - 1. Tripping Characteristic: Designed specifically for generator protection.
 - 2. Trip Rating: Matched to generator rating.
 - 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.

2.11 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1 and specified performance requirements.
- B. Drive: Generator shaft is directly connected to engine shaft. Exciter is rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction prevents mechanical, electrical, and thermal damage due to vibration, over speed up to 125% of rating, and heat during operation at 110% of rated capacity.
- F. Excitation uses no slip or collector rings, or brushes, and is arranged to sustain generator output under short-circuit conditions as specified.
- G. Enclosure: Drip proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel provides plus or minus 5% adjustment of output- voltage operating band.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Sub transient Reactance: 12%, maximum.

2.12 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/ h). Multiple panels are lockable and provide adequate access to components requiring maintenance. Panels are removable by one person without tools. Instruments and controls are mounted within enclosure.
- B. Muffler Location: External to enclosure.
- C. Engine Cooling Airflow through Enclosure: Adequate to maintain temperature rise of system components within required limits when unit operates at 110% of rated load for two hours with ambient temperature at top of range specified in system service conditions.
- D. Louvers: Fixed-engine cooling air inlet and discharge. Louvers prevent entry of rain and snow.
- E. Automatic Dampers: At engine cooling air inlet and discharge. Dampers are closed to reduce enclosure heat loss in cold weather when the unit is not operating.

2.13 FACTORY TEST

- A. Provide a factory test and certified report of the test. Report shall substantiate the unit's full power rating, stability, voltage, and frequency regulation.
- B. Provide with the test report complete operating instructions and maintenance manuals with parts list and maintenance recommendations.

2.14 OTHER PRODUCTS

- A. Wiring System
 - 1. Refer to Section 26 27 00 for product information.
- B. Emergency Lighting
 - 1. Refer to Section 26 50 00 for product information.

- C. Fire Alarm System
 - 1. Refer to Section 28 30 00 for product information.
- D. Nurse Call System
 - 1. Refer to Section 27 52 33 for product information.
- E. Automatic Transfer Switches
 - 1. Refer to Section 26 32 23 for product information.

PART 3 - EXECUTION

3.01 WIRING

- A. Prior to acceptance of portable generator set, perform 100% rated output test at construction site with temporary load bank of appropriate size. Upon acceptance, make temporary connections as required.
- B. All wiring shall be in galvanized steel conduit and shall be installed in accordance with the manufacturers wiring diagrams.
- C. Wiring shall be in accordance with the NEC and the local authorities having jurisdiction.
- D. Connections to the generator shall be made flexible.
- E. Provide control wiring from all automatic transfer switches (including those provided under separate contract, such as fire pump controllers) to the generator.

3.02 GENERATOR

- A. *The generator shall be mounted on a concrete pad, minimum 0'-6" thick, reinforced concrete.
- B. Arrange for fuel installation of natural gas.
- C. Install a 0'-1" static deflection vibration isolation.
- D. Install critical muffler and muffler tailpipe to the exterior. Muffler/ tailpipe shall be flexibly coupled to the engine with a stainless-steel exhaust connector.

3.03 TESTING

- A. Perform field quality control testing under the supervision of the manufacturer's factory authorized service Representative.
- B. Furnish load bank of adequate size to test generator at 100% rated output prior to connection to building emergency power system.
- C. Perform tests as recommended by manufacturer.
- D. Coordinate tests with tests of automatic transfer switches and run them concurrently.
- E. Correct deficiencies identified by tests and retest until requirements are met.

3.04 DEMONSTRATION

- A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the generator set.
- B. Coordinate this training with that of the transfer switches.
- C. The minimum training session is to be eight hours.

END OF SECTION

SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to section 26 00 00 for requirements which are applicable to this section.
- B. Refer to National Electrical Code (NEC).
- C. Refer to NEMA, UL and IEEE Standards.
- D. Refer to NFPA 110.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to furnish, install, and place into operation automatic transfer switches with number of poles, amperage, voltage and withstand ratings as indicated on the plans and specified herein.
- B. Provide necessary controls between the automatic transfer switch and the power system to ensure proper operation and power transfer.

1.03 SUBMITTALS

- A. Submit shop drawings of switches and accessories.
- B. Submit manufacturer's data sheets of equipment.
- C. Submit manufacturer's certificates of conformance with applicable codes.
- D. Submit wiring diagrams of switches and accessories.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.
- B. Install systems and equipment in accordance with NEC.
- C. Provide adequate supervision of the labor force to see that installations are correct.

PART 2 - PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH

- A. Furnish and install switch system(s) with number of poles, amperage, voltage and withstand ratings as shown on the plans. The system shall comply with the latest requirements of Underwriters' Laboratories UL Std. 1008 and NEMA ICS10-1993, (formerly Std. ICS 2-447). In addition, the switch performance must meet or exceed the following requirements and, if so requested, be verified by certified laboratory test data: Temperature Rise, withstand, dielectric and transient withstand tests.
- B. Automatic transfer switch systems shall meet all the requirements of the specification and as

a minimum be equal to an ASCO 300 Series.

- C. Acceptable Manufacturers: ASCO, SIEMENS (Russelectric), ABB (Zenith), Kohler, Cummins, or Caterpillar.

2.02 AUTOMATIC TRANSFER SWITCH OPERATION

- A. Electrical operation shall be accomplished by a momentarily energized single solenoid operating mechanism which receives power from the source to which the load is being transferred. Fuse or thermal protection of the main operator is prohibited. The operating transfer time shall be one-sixth of a second or less. Mechanical locking in each position shall be accomplished without the aid of permanent magnets, latching solenoids or power operators. Operation shall be true double throw with no possibility of a neutral position. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and power conductors. A manual operating handle shall be provided for maintenance purposes.
- B. The automatic transfer switch shall include a separately mounted control panel with adjustable solid-state sensing and timing functions. The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and with inherent digital serial communications capability. The control module shall be connected to the transfer switch by an interconnection wiring harness. The harness shall include a keyed disconnect plug to enable the control module to be disconnected from the transfer switch for routine maintenance.
- C. Where neutral conductors must be switched, the ATS shall be provided with fully rated neutral transfer contacts. When neutral conductors are to be solidly connected, a neutral terminal plate with fully rated AL-CU pressure connectors shall be provided.
- D. The ATS shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans.
- E. Provide strip heater with thermostat for Type 3R enclosure requirements.
- F. Controller shall be flush-mounted display with LED indicators for switch position and source acceptability. It shall also include test and time delay bypass switches.

2.03 STANDARD ACCESSORIES

- A. 1-3 second adjustable transfer time delay. (1 second factory set)
- B. 0-5 minute adjustable time delay on transfer to emergency. Controls loading of generator. (0 minutes factory set)
- C. 0-30 minute adjustable time delay on retransfer to normal. Time delay is automatically bypassed if emergency source fails (30 minutes factory set).
- D. Toggle switch- Manually bypasses time delay on retransfer.
- E. 5-minute cool-down time delay on engine shutdown.
- F. Adjustable close differential voltage sensing of all normal source phases.
1. Pickup voltage 85-100% (Factory set - 95% of nominal voltage)
 2. Dropout voltage 70-90% (Factory set - 85% of nominal voltage)
- G. Adjustable independent emergency voltage and frequency sensing.
1. Pickup voltage 85-100% (Factory set - 90% of nominal voltage)
 2. Pickup frequency 90-100% (Factory set - 95% of nominal frequency)
- H. All settings field adjustable with no special tools required.
- I. Test switch - Simulates failure of normal source. (Momentary type)
- J. Gold plated engine starting contacts. (10-amp SPDT)
- K. Pilot lights- Indicate switch position. Auxiliary contacts-1-N/C and 1-N/O on "Normal" (10

- amps,
480 VAC.)
- L. Microprocessor- Output terminals shall be provided to signal the actual availability of the normal and emergency sources, as determined by the voltage sensing pickup and dropout settings for each source.
 - M. An engine generator exerciser shall be provided where so indicated on the plans. The exercising timer shall be built-in to the ATS module and shall include a selector switch to select exercise with or without load transfer. Exercise setting shall be set by pushbutton and a digital display shall be provided to indicate settings.
 - N. An in-phase monitor shall be inherently built into the controls. The monitor shall control transfer/retransfer operation between live sources so that closure on the alternate source will occur only when the two sources are within 15 electrical degrees maximum so that inrush currents do not exceed normal starting currents. The monitor shall function over a frequency difference range of up to +2.0 Hz with maximum operating transfer time of one-sixth of a second. If the voltage of the load-carrying source drops below 70%, the in-phase function shall be automatically bypassed. The monitor shall not require inter-wiring with the generator controls, or active control of the governor.
 - O. Switched neutrals (shown as 4 pole switches on the drawings) shall have fully rated neutral transfer contacts.

2.04 ASCO OPTIONAL ACCESSORY NUMBER - 72A

- A. Serial communications: The control module shall include provisions for future serial communications capability. Serial communication shall provide for remote: position indication, testing, source availability (as defined by the actual pick-up and drop-out settings), and indication of any time delay currently in operation of all Automatic Transfer Switch(es).

2.05 ASCO OPTIONAL ACCESSORY NUMBER 44G

- A. Enclosure Heater - a 125 W enclosure heater with transformer and thermostat, adjustable from 30°F to 140°F.

2.06 WITHSTAND AND CLOSING RATINGS

- A. The ATS shall be rated to close on and withstand the available rms symmetrical short circuit current at the ATS terminals with the type of over-current protection shown on the plans. WCR ATS ratings as be as follows when used with specific circuit breakers:

ATS Size	Withstand & Closing Rating MCCB	W/CLF
30	22,000A	100,000
70 - 200	22,000A	200,000
230	22,000A	100,000
260 - 400	42,000A	200,000
600 - 1200	65,000A	200,000
1600 - 2000	85,000A	200,000
2600 - 3000	100,000A	200,000

PART 3 - EXECUTION

3.01 AUTOMATIC TRANSFER SWITCHES

- A. Furnish and install automatic transfer switches on all motors which do not have integral equipment transfer switches.
- B. Furnish and install automatic transfer switches where indicated on the drawings.
- C. Automatic transfer switches shall be installed to meet the area classification as to standard, hazardous, rainproof, etc.
- D. Automatic transfer switches shall be installed securely to building structure or be provided with supplemental support steel such as angle iron or unistrut when required to locate on other than building structure.
- E. All automatic transfer switches shall be grounded.
- F. Furnish and install control wiring from each automatic transfer switch to the generator.
- G. Power transfer shall be as follows:
 - 1. Life Safety ATS: Within 10 seconds of power failure.
 - 2. Standby power ATS: Staggered from one minute to five minutes past the power failure to ensure generator accepts the loads. Coordinate ATS transfer with owner (i.e., ATS for HVAC may be more critical than UPS transfer).
 - 3. Fire Pump: Within ten seconds of power failure.

3.02 TESTING

- A. Perform field quality control testing under the supervision of the manufacturer's factory authorized service representative. Coordinate testing with that of emergency generator testing.

3.03 DEMONSTRATION

- A. Engage a factory authorized service representative to train owner's personnel to adjust, operate, and maintain transfer switches. Coordinate training with generator equipment training.

END OF SECTION

SECTION 26 43 13 - SURGE SUPPRESSION

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 26 00 00 for requirements which are applicable to this section.
- B. Refer to National Electrical Code.
- C. Refer to UL, ANSI, IEEE, and NEMA Standards.
- D. Refer to Computer Business Manufacturer's Association (CBEMA), Information Technology Industry Council (ITIC) and International Electrotechnical Commission (IEC) for clamping voltage tolerance guidelines for sensitive equipment.

1.02 WORK INCLUDED

- A. Provide all labor, material, equipment, and supervision necessary to install and place into operation surge suppression where indicated on drawings and/or specifications.

1.03 SUBMITTALS

- A. Submit shop drawings, product data, and manufacturer's installation instructions.
- B. The surge suppression submittal shall also include:
 - 1. Dimensional drawing of each suppressor type indicating mounting arrangements.
 - 2. UL 1449 Third Edition documentation (SCCR, VPR, MCOV, I-n).
- C. All Surge Protective Devices shall be of the same manufacturer.

1.04 QUALITY ASSURANCE

- A. Verify that all equipment is installed in accordance with the manufacturer's warranty requirements.
- B. Install equipment with accordance with National Electrical Code.
- C. Provide adequate supervision of labor force to see that installations are correct.
- D. Surge protection devices shall be manufactured in the USA, by a company normally engaged in the design and manufacture of such devices for at least ten years.

1.05 SAFETY AGENCY APPROVALS

- A. Suppressers shall be listed in accordance with UL 1449 3rd Edition documentation, standard for safety, surge protective devices and meet requirements in UL 1283 for electromagnetic interference filters.

PART 2 - PRODUCTS

2.01 SERVICE ENTRANCE

- A. Surge protection devices shall be installed at all service entrances of each building and/ or as shown on the riser diagram.
- B. Suppressers shall be tested per ANSI/IEEE C62.45.
- C. Wye systems shall have suppression elements between each phase conductor and the system neutral, between each phase conductor and the system ground and between the neutral conductor and ground (true 10-mode protection).
- D. Each phase shall have a minimum of two modules. The surge modules shall be fused at a minimum rating of 30 Amp. Modules and fuses shall be field replaceable. Fuses shall be surge suppression fuses. (Ferraz Shawmut VPS Series)
- E. Visible indication of proper suppresser connection and operation shall be provided. The indicator shall consist of an LED array. No single LED or neon indicators will be used.
- F. The surge protection device shall be equipped with an audible alarm that shall actuate when any part of the surge circuitry has been damaged. A silence button shall be provided with the alarm.
- G. The suppressor shall exhibit Sine Wave Tracking circuitry and shall provide high frequency noise filtering up to 50dB attenuation (100 kHz-100 MHz).
- H. Suppressors shall meet or exceed the following criteria:
 - 1. Minimum single impulse current rating (L-N + L-G): 160,000 Amp per phase, 80 kA per mode.
 - 2. Incorporate hybrid circuitry.
 - 3. UL 1449 3rd Edition voltage protection ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-L	L-L	MCOV
120/208	800	800	800	1200	150
277/480	1200	1200	1200	2000	320

- I. Suppressors shall exhibit redundant protection for each phase and consist of solid-state components and shall operate bi-directionally.
- J. Suppressor shall be equipped with a surge counter with a reset and battery backup.
- K. Suppressor short circuit current rating shall meet or exceed that of the service panelboard.
- L. Total Protection Solutions (Joslyn) Surge Track ST160 or approved equivalent by Advanced Protection Technologies, Inc., Siemens, ABB Group, Eaton, Square D, or LEA International.

2.02 SECONDARY DISTRIBUTION INTEGRATED SUPPRESSION PANELS:

- A. Surge Protective Devices shall be installed in secondary distribution panels as shown on the riser diagram.
- B. Suppressor shall be tested per ANSI/IEEE C62.45.
- C. Wye systems shall have suppression elements between each phase conductor and the system neutral, between each phase conductor and the system ground and between the neutral conductor and ground (true 10-mode protection).
- D. Visible indication of proper suppressor connection and operation shall be provided.
- E. The surge protective device shall be equipped with an audible alarm that shall actuate when any part of the surge circuitry has been damaged. A silence button shall be provided with the alarm.
- F. The suppressor shall exhibit Sine Wave Tracking circuitry. The surge suppressor shall have suppression circuitry that is field replaceable without disturbing the conduit or enclosure.
- G. Suppressors shall meet or exceed the following criteria:
 - 1. Minimum single impulse current rating (L-N + L-G): 80,000 amperes per phase, 40kA

per mode.

2. UL Clamping voltage shall not exceed the following:

VOLTAGE	L-N	L-G	N-L	L-L	MCOV
120/208	800	800	800	1200	150
277/480	1200	1200	1200	2000	320

- H. Suppressors shall consist of solid-state components and operate bi-directionally. The manufacturer of the surge panel shall offer either a surface or flush cover, as required by the job conditions.
- I. Suppressor short circuit current rating shall meet or exceed that of the panelboard.
- J. Total Protection Solutions (Joslyn) Surge Track ST80 or approved equivalent by Advanced Protection Technologies, Inc., LEA International, Siemens, GE, Eaton, or Square D.

PART 3 - EXECUTION

3.01 SERVICE ENTRANCE

- A. Install one primary suppressor at each utility service entrance. Follow manufacturer's installation instructions.
- B. Suppressor shall be installed on the load side of the service entrance.
- C. Conductors between suppressor and point of attachment shall be at least #6 AWG stranded copper conductor or larger. The conductors shall be kept as short and straight as possible. Lead length of connecting conductors shall be within 3'-0".
- D. Suppressor's ground shall be bonded to the service entrance ground.

3.02 SECONDARY DISTRIBUTION PANELS

- A. Install one secondary suppressor at each distribution panel location or as indicated on the riser diagram. Follow manufacturer's installation instructions.
- B. Suppressor shall be installed on the service panel, per the manufacturer's installation instructions. Contractor shall install circuit breaker in panel to attached surge panel to electrical distribution system if necessary.
- C. Conductors between suppressor and point of attachment shall be at least #6 AWG stranded copper conductor or larger. The conductors shall be kept as short and straight as possible. The maximum length of connecting wiring shall not exceed 1'-6". Pre-wired suppressors with conductors smaller than #6 wire are not acceptable.
- D. Suppressor's ground shall be connected to the distribution panel ground.

3.03 CERTIFIED TESTS

- A. The surge suppresser manufacturer shall provide certified test results on the actual product being shipped to the job site. The test results shall be certified by an officer or engineer of the company as being performed on the product after manufacture.
- B. The test conducted shall be per ANSI/IEEE C62.45. The units shall be tested in all modes listed in this specification.

3.04 WARRANTY

- A. The surge suppresser shall warrant the surge protective devices and supporting components against defects in material and workmanship for a minimum period of five years.

3.05 TESTING

- A. Perform field quality control testing under the supervision of the manufacturer's factory authorized service representative.

3.06 DEMONSTRATION

- A. Engage a factory authorized service representative to train owner's personnel to adjust, operate, and maintain equipment.

END OF SECTION

SECTION 26 50 00 - LIGHTING

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 26 00 00 for other requirements of this Section.
- B. All work to conform to the NFPA 70 National Electrical Code.
- C. Provide interior lighting controls to meet the adopted IBC / IECC / ASHRAE 90.1 code. Refer to Specification Section 26 09 00 for additional requirements.
- D. Refer to standards of the Illuminating Engineering Society.
- E. All exit and emergency lighting shall comply with NFPA Life Safety Code 101, ADA, and other local codes as may apply.

1.02 SCOPE

- A. Furnish and install a complete and operating lighting system, including all luminaires, wiring, lamps, and 0-10V dimmable LED drivers.
- B. All lighting outlets shall have a luminaire. If a luminaire designation is missing, furnish and install a luminaire in similar use in the project.
- C. All luminaires shall have a home run. If these are omitted on the drawings the contractor shall allow for a home run to the nearest appropriate panel.
- D. All rooms are to be provided with lighting controls. Provide manual switch and code required control devices as appropriate. If controls are not indicated within a space, controls are to be provided for the space in a similar manner as adjacent or similar spaces.
- E. Provide exit and emergency lighting as required by Code in all spaces to meet requirements of the AHJ. Allow for ten additional luminaires to be installed where directed by the AHJ.

1.03 MOUNTING

- A. The contractor shall be responsible for selecting mounting arrangements of luminaires to suit the construction or ceiling types. Contractor or his agent shall review architectural drawings to establish ceiling types prior to preparing shop drawings for submission. It is NOT to be understood that the luminaire schedule accounts for the mounting types. Frequently ceiling types are changed after the luminaire schedule has been completed.
- B. Luminaires shall be mounted on structurally secure supports. The contractor shall provide miscellaneous steel supports to span between structural elements to provide a base of support for the luminaires at the locations shown on the drawings. Refer to architectural and structural drawings for locations of beams, joists, purlins, etc.
- C. Exterior luminaires shall be mounted with anchor bolts of suitable size secured into concrete bases. The mounting arrangement shall be capable of withstanding a continuous wind of 100 MPH with gales to 130 MPH. EPA of luminaire shall be rated with pole to provide required performance.

1.04 APPROVALS

- A. Furnish shop drawings and catalog cuts of all luminaires for review by the engineer prior to

- ordering.
- B. Provide samples of any luminaire or luminaires when requested by the owner, architect, or engineer.
 - C. Provide a point-by-point lighting level calculation for parking areas, areas when requested by the engineer, and for high profile areas (i.e., main lobbies, atriums, pools, gymnasiums, etc.), when an alternate manufacturer or luminaire is being presented for approval. Calculation shall be provided by the manufacturer or the local manufacturer's representative. Footcandle levels are to be indicated at a maximum of 10'-0" intervals (exterior) or 5'-0" intervals (interior). A drawing is to be provided at the same scale as the contract documents.

PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

- A. Luminaires shall be complete with wiring, lamp holders, lamps, reflectors, glassware, canopies, shades, bases, pendants, etc.
- 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. Luminaires shall be wired with type AF luminaire wire.
- D. Plastic lenses shall not be used. Provide either virgin acrylic, high impact polycarbonate or tempered glass or as specified in the luminaire schedule. Lens thickness shall be a minimum of 1/8".
- E. Any exposed luminaire housing surface, trim frame, door frame and lens frame shall be free of light leaks either between luminaire components or between luminaire and adjacent surface.
- F. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.
- G. Hinged door closure frames shall operate smoothly and easily without binding when installed and latches shall function easily by finger action without the use of tools.
- H. Recessed luminaires installed in an insulated ceiling shall be listed for use in insulated ceilings.
- I. Luminaires in damp areas shall be gasketed, vapor tight, and fabricated with aluminum instead of steel. These luminaires shall have pressure clamping devices in lieu of latches.
- J. Luminaires located in other harsh environments are to be of suitable construction and finish for the intended environment in addition to the requirements listed in the Lighting Luminaire Schedule.
- K. All luminaire lenses shall, from the manufacturer, be shipped within a protective covering, i.e. plastic bag, paper wrapped, to prevent dust, dirt, smudges prior to final acceptance.
- L. Drivers shall be easily serviceable when installed and shall not be mounted to removable reflectors or wire way covers.
- M. Luminaires shall have a minimum CRI of 80 and a CCT of 3500 K.
- N. Luminaires shall have a rated lamp life of 50,000-hours to L70.
- O. Luminaires shall be dimmable from 100% to 10% of maximum output.

2.02 LED DRIVERS

- A. Shall be internal.
- B. Shall be designed for ten-year operational life.
- C. Shall be designed to withstand electrostatic discharges according to IEC 61000-4-2.
- D. Shall be furnished with poke-in wire trap connectors, color coded to ANSI standard C82.11.
- E. Shall operate from a line voltage range of 108-305-volts, 50/60 Hz.
- F. Input current shall have Total Harmonic Distortion (THD) of less than 20% with a power factor of >.90% to comply with ANSI standard C82.11
- G. Shall meet UL 8750, UL 1012, and UL 1310 as applicable in NFPA compliant installations.
- H. Shall have no visible output change at $\pm 10\%$ line voltage input.
- I. Shall have a Class A sound rating (inaudible at 27dBA ambient noise level).
- J. Shall have a universal input voltage (120-277V/ 50-60Hz).
- K. Shall be Underwriters Laboratories (UL) Listed (Class P) and CSA Certified where applicable and rated for use in air handling spaces.
- L. Shall carry a five-year warranty from the date of manufacture for operation at a case temperature of 75°C or less. When operated at a case temperature between 75°C and 85°C, the warranty shall be three years from the date of manufacture.

2.03 LED EQUIVILANT LAMPS

- A. LED: ENERGY STAR Certified, NRTL compliant, FM Global compliant. Recessed luminaires shall comply with NEMA LE4, CRI: 80, CCT: 3500 K. Lamps dimmable from 100% to 10% of maximum light output, 50,000-hour lamp rated life, internal driver must be UL Listed, dimmable with any standard dimmer switch, smooth, flicker-free dimming.
- B. Manufacturers; Philips, Feit, Sylvania, GE, Archipelago.
- C. Contractor is to coordinate lamp color for all luminaires. Lamp color is to be similar in all spaces.

2.04 EMERGENCY LIGHTING UNITS

- A. General requirements: Self-contained units, thermoplastic enclosure, comply with UL 924. Units include the following features:
 - 1. Battery: Sealed, maintenance-free, lead-acid type with minimum ten-year nominal life and special warranty, 12-volt, remote capacity as required.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when 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, and battery is automatically recharged and floated on charger.
 - 4. Wire Guard: Where indicated, heavy-chrome-plated wire guard arranged to protect lamp heads or luminaires.
 - 5. Integral Time Delay Relay: Arranged to hold unit on for fixed interval after restoring power after an outage. Provides adequate time delay to permit high-intensity-discharge lamps to restrike and develop adequate output.
 - 6. Test switch and LED pilot light
 - 7. Self-diagnostic circuitry.
- B. Manufacturers: Emergi-Lite, Dual-Lite, Chloride, Sure-Lites

2.05 EMERGENCY LED POWER SUPPLY UNIT

- A. Integral Type: Self-contained, modular, battery-inverter unit factory mounted within luminaire body. Comply with UL 924.
 - 1. Test Switch and Light-Emitting Diode Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - 2. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum ten-year nominal life.
 - 3. Charger: Fully automatic, solid-state, constant-current type.
 - 4. Operation: Relay automatically energizes lamp from unit when normal supply circuit voltage drops to 80% of nominal voltage or below. When normal voltage is restored, relay disconnects lamp and battery is automatically recharged and floated on charger.
 - 5. Light output:
 - a. Minimum 1,400 lumens for LED luminaires.

2.06 EMERGENCY LIGHTING INVERTER

- A. Remote Type. Self-contained, modular, battery-inverter. Comply with UL 924, NFPA 101, and installed per the National Electrical Code.
- B. The sensing/ transfer equipment shall consist of a transfer relay and solid-state switch. Total transfer from standby to emergency operation shall be accomplished in less than one second after loss or interruption of normal AC power.
- C. The battery charger shall include a ferro resonant transformer and a full wave rectifier. It shall be of solid-state construction and shall provide three rates of charge. The charger shall incorporate a digital, solid-state timer which periodically allows an automatic equalizing charge to be applied to the batteries.
- D. The solid-state DC-to-AC inverter shall have a ferro resonant output transformer which provides 120-volt, or 277-volt +/- 5% of single phase, 60Hz +/- 1Hz emergency power. The design shall yield a sinusoidal output waveform with maximum 10% Total Harmonic Distortion. Efficiency shall be not less than 75%.
- E. Designed system protection shall include a Low Voltage Battery Disconnect feature, short-circuit protection, current-limiting feature, and overload protection of 130%.
- F. Batteries shall be lead-calcium.
- G. Supervisory instrumentation and controls shall include, but not be limited to, battery DC voltmeter, output AC voltmeter, AC utility power "on" light, emergency power "on" light, system test switch to simulate normal AC power failure, high charge indicator light and charge current ammeter.
- H. The entire system shall be enclosed in a heavy-gauge, commercial-grade steel cabinet, enamel-finished in beige hammer tone and including hinged, lockable doors. The cabinet shall be free-standing or wall-mounted, and batteries shall be positioned below the modular electronics for easy maintenance.
- I. Manufacturers; IOTA, DUAL LITE, Bodine, Emergi-Lite/ ABB, Myers or equal.

2.07 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. Refer to Luminaire Schedule on drawings.
- B. Internally lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type) Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80% of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. 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 a flashing red LED.

PART 3 - EXECUTION

3.01 LUMINAIRES

- A. All recessed LED troffers (2' x 2', 2' x 4', and 1' x 4') and recessed luminaires weighing up to 20 lbs. are to be installed in grids with mounting clips and with grid secured at diagonal corners of luminaire to the building structure. (4' x 4') luminaires to be secured at four corners.
- B. Recessed luminaires between 20 and 50 pounds are to have, in addition to above, 12-gauge steel safety chains at opposite corners hung slack from the building structure. Luminaires above 50 pounds to be independently supported directly from the structure with approved hangers and angular sway bracing according to manufacturer's installation guidelines.
- C. Surface mounted and pendant luminaires under 15 pounds can be supported directly from the outlet box when all of the following apply: screws pass through round holes and not key slots in the luminaire body, the outlet box is attached to a main ceiling runner, and the outlet box is supported vertically from the building structure.
- D. Surface luminaires between 15 and 50 pounds shall be bolted to the ceiling independent of the outlet box. Luminaires over 50 pounds shall be secured to the building structure using a manufacturer's approved mounting method.
- E. Luminaires to be set plumb.
- F. Provide 6'-0" flexible leads on recessed luminaires to allow for easy removal.
- G. Recessed luminaires shall be set with mounting frames.
- H. Coordinate final location of all luminaires with other disciplines to avoid interferences and potential obstructions as the work progresses.
- I. Luminaires used for temporary lighting during construction shall be removed, cleaned, and re-installed prior to acceptance of the lighting system.
- J. Luminaires shall be cleaned and free of all dirt, dust, smudges, and surface imperfections just prior to final acceptance.
- K. Luminaires which are recessed in a fire rated ceiling shall be provided with an enclosure around the luminaire which shall maintain the fire rating integrity of the ceiling system. The

installation of the enclosure shall meet the requirements of the authority having jurisdiction.
The luminaire shall be insulation rated for higher temperature operation.

- L. All recessed or surface mounted luminaires on or in sloped ceilings shall have sloped ceiling adapters to allow for vertical light distribution.

3.02 SWITCHING

- A. Provide lighting control switch legs to wall switches for all luminaires except for those operated by integral switches.
- B. Provide 3-way or 4-way control where indicated and for rooms with more than one entrance.
- C. Provide a single time clock, contactors and relays as indicated on the drawings and as necessary for site lighting and parking lot lighting control.
- D. Provide interior lighting controls to meet IBC 2015/IECC 2015/ ASHRAE 90.1. Refer to Specification Section 26 09 00 for additional requirements.

END OF SECTION

SECTION 28 13 00 - SECURITY SYSTEM

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 26 00 00 for requirements which are applicable to this section.

1.02 WORK INCLUDED

- A. Provide labor, material and supervision necessary to install a complete security entry system as outlined in this section.

1.03 SUBMITTALS

- A. Furnish shop drawings and/or descriptive data for this section.
- B. Furnish wiring diagrams of system.

PART 2 - PRODUCTS

2.01 SCOPE

- A. Furnish and install a security entry and motion detection system as shown on the drawings.
 - 1. Touch dial the three digit code for entry.
 - 2. Infrared motion detectors.
 - 3. Emergency police, fire, ambulance, or manager can be put into system.
 - 4. Touch Pad Programming.
 - 5. Flashing red light when invalid code has been dialed.
 - 6. Emergency Power Supply.
 - 7. Capacity for future building addition with no modification.
 - 8. Telephone dialer for alarm transmission.
 - 9. Door alarms at every perimeter door.

PART 3 - EXECUTION

3.01 WIRING

- A. Power supply operates from a standard duplex outlet. Conduit from control to incoming telephone system for the building.
- B. All wiring shall be run in conduit, and shall be installed as recommended by the system

- manufacturer.
- C. A service contract shall be made available to the owner after the one year warranty expires.
- D. Install motion detectors where indicated on the drawing selected for the sensitivity and range appropriate.
- E. Install recessed touch pads at two exterior door locations.

END OF SECTION

SECTION 28 30 00 - FIRE ALARM AND DETECTION SYSTEMS - ADDRESSABLE - HORN

PART 1 - GENERAL

1.01 REFERENCE

- A. Refer to Section 26 00 00 for requirements which are applicable to this section. All work required is not limited to this section.

1.02 WORK INCLUDED

- A. Provide labor, material, equipment and supervision necessary to install a complete electrically supervised microprocessor based, fully addressable type system as outlined in this section.
- B. * Equipment by EST, Notifier, Siemens, Simplex.
- C. Faraday, Gamewell, Firelite, Silent Knight, or approved equivalent manufacturer is acceptable provided that all design criteria are satisfied.
- D. It is the intent of this specification and accompanying drawings to require the contractor and/or supplier of equipment and devices to provide a complete code compliant system which will obtain, as a minimum, the approval of the AHJ. Different suppliers may have devices which differ between each other and as such all devices necessary for approval shall be included in the scope of work whether specifically identified or not.
- E. Horns shall be audible as required by code in all spaces above ambient. Devices provided by manufacturers shall be selected to provide audibility with either additional horns or higher dB devices as necessary to achieve such approval.
- F. Strobes shall be visible as required by code in all spaces to meet requirements of the AHJ.
- G. All fire alarm system components are to be appropriately rated for the environment in which they are being installed. The fire alarm vendor is responsible for UL Listed device selections. Consideration shall be given to, but not be limited to, ambient temperature, water infiltration, dust infiltration, and humidity.
- H. In order to meet the approval of the AHJ, it may be necessary to add additional devices that are not indicated on the drawings. The contractor is to allow for 12 additional devices and wiring.

1.03 SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
- B. Shop Drawings: For fire-alarm system.
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Include plans, elevations, sections, details, and attachments to other work.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 - 4. Include voltage drop calculations for notification-appliance circuits.
 - 5. Include battery-size calculations.

6. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
 7. Include performance parameters and installation details for each detector.
 8. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 9. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. General Submittal Requirements:
1. Submit drawings to the local authority for permit and approval. Submit approved drawings to consulting engineers and to owner's insurance company and obtain approval prior to construction. All requirements for above approval are to be included with the work.
 2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level III minimum.
 - c. Licensed or certified by authorities having jurisdiction.

1.04 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Control of System: By the Fire Alarm Control Panel (FACP).
- B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
- C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.
- D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.
- E. System Reset: All zones are manually resettable from the FACP after initiating devices are restored to normal.
- F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.
- G. System Alarm Capability during Circuit Fault Conditions: System wiring, and circuit arrangement prevent alarm capability reduction when an open circuit, ground or wire-to-wire short occurs, or an open circuit and a ground occur at the same time in an initiating device circuit, signal line circuit, or notification-appliance circuit.
- H. Loss of primary power at the FACP initiates a trouble signal at the FACP and the annunciator. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.
- I. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke or flame or heat detector, or operation of a sprinkler flow device initiates the following:
 1. Notification-appliance operation (exterior bell/ strobe only operates with sprinkler flow devices).

2. Identification at the FACP and the remote annunciator of the device originating the alarm.
 3. Transmission of an alarm signal to the remote alarm receiving station.
 4. Unlocking of electric door locks in designated egress paths.
 5. Release of fire and smoke doors held open by magnetic door holders.
 6. Recall of elevator(s).
 7. Shutdown of fans and other air-handling equipment serving zone when alarm was initiated.
 8. Closing of smoke dampers in air ducts of system serving zone where alarm was initiated.
 9. Recording of the event in the system memory.
 10. *Recording of the event by the system printer.
- J. Alarm Silencing, System Reset and Indication: Controlled by switches in the FACP (and the Remote Annunciator).
1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- K. Water-flow alarm switch operation initiates the following:
1. Notification-appliance operation.
 2. Flashing of the device location-indicating light for the device that has operated.
 3. Notification-appliance operation on exterior.
- L. Operating a heat detector in the elevator shaft shuts down elevator power by operating the shunt trip in a (all) circuit breaker(s) feeding the elevator(s). Refer to 26 00 00 for sequence of operation.
- M. Water-flow alarm for connection to sprinkler in an elevator shaft and elevator machine room shuts down elevators associated with the location without time delay.
1. A field-mounted relay actuated by the fire detector or the FACP closes the shunt trip circuit and operates building notification appliances and annunciator.
- N. Smoke detection for zones or detectors with alarm verification initiates the following:
1. Audible and visible indication of an "alarm verification" signal at the FACP.
 2. General alarm if the alarm is verified.
 3. Cancellation of the FACP indication and system reset if the alarm is not verified.
- O. Sprinkler valve-tamper switch operation initiates the following:
1. A supervisory, audible, and visible "valve-tamper" signal indication at the FACP and the annunciator.
 2. Flashing of the device location-indicating light for the device that has operated.
 3. Transmission of supervisory signal to remote alarm receiving station.
- P. Fire-pump power failure, including a dead-phase or phase-reversal condition, initiates the following:
1. A supervisory, audible, and visible "fire-pump power failure" signal indication at the FACP and the annunciator.
 2. Transmission of trouble signal to remote alarm receiving station.
- Q. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system initiates the following:
1. A supervisory, audible, and visible "sprinkler trouble" signal indication at the FACP

- and the annunciator.
- 2. Flashing of the device location-indicating light for the device that has operated.
- 3. Transmission of trouble signal to remote central station.
- R. Remote Detector Sensitivity Adjustment: Manipulation of controls at the FACP causes the selection of specific addressable smoke detectors for adjustment, display of their current status and sensitivity settings, and control of changes in those settings. Same controls can be used to program repetitive, scheduled, automated changes in sensitivity of specific detectors. Sensitivity adjustments and sensitivity-adjustment schedule changes are recorded in system memory and are printed out by the system printer.
- S. Removal of an alarm-initiating device or a notification appliance initiates the following:
 - 1. A "trouble" signal indication at the FACP and the annunciator for the device or zone involved.
 - 2. Transmission of trouble signal to remote alarm receiving station.
- T. FACP Alphanumeric Display: Plain-English-language descriptions of alarm, supervisory, and trouble events; and addresses and locations of alarm-initiating or supervisory devices originating the report. Display monitoring actions, system and component status, system commands, programming information, and data from the system's historical memory.

PART 2 - PRODUCTS

2.01 CONTROL PANEL

- A. Fire Alarm Panel shall be surface mounted where shown on the drawings, with the following items.
 - UL Listed
 - Modular, microprocessor-based
 - Addressable locations of all devices
 - Zoned Visual Alarm and Trouble Indicators
 - Automatic Ground Detection
 - Lamp Test
 - Supervisory Voltage and Current Meters
 - Double Supervision
 - Field Programmable Fan Relays
 - Supervise Signal Circuit Modules
 - Annunciator Contacts by Zone
 - Dead Front Construction
 - Battery backup

2.02 SMOKE DETECTORS

- A. Furnish and install where shown on the drawings UL listed smoke detectors. Detector shall be solid state photoelectric type and shall operate on the light scattering, photo diode principle. Detector shall have an integral fixed temperature heat detector rated at 135°F.
- B. Detector shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

2.03 HORN/ STROBE

- A. Combination device with factory integrated audible and visible devices in a single mounting assembly. Horn shall be electric vibrating polarized type which produces 90 dB measured 10'-0" from the horn. Strobe shall be self-synchronizing, Xenon strobe lights with clear lens and rated light output of 15, 30, 60, 75, or 110 candelas.

2.04 STROBE

- A. Self-synchronizing, flush wall mounted, red housing, white letters, UL 1638 and UL 1971 compliant 15, 30, 60, 75, or 110 candelas as appropriate, mounted on single-gang box, clear Lexan flash tube enclosure.

2.05 MINI-HORN/ STROBE

- A. Similar to Horn/ Strobe except 110 candela strobes, 75 dB measured at 10'-0".

2.06 FIRE ALARM STATIONS

- A. Fire Alarm Stations shall be semi-flush mounted, non-code break glass type. Finish shall be red with white letters.
- B. Stations shall be addressable.

2.07 HEAT DETECTORS

- A. Heat Detectors, furnished and installed where indicated on the drawings, shall be combination type, actuated by either a fixed temperature of 135°F or rate of rise of temperature that exceeds 15°F per minute.
- B. Detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

2.08 DUCT SMOKE DETECTORS

- A. Furnish where indicted on the drawings or required elsewhere in the specifications air duct smoke detectors. Duct smoke detectors are to be furnished by the electrical contractor, installed by the mechanical contractor, and wired to the fire alarm system by the electrical contractor. They shall integrate photoelectric, ionization and heat sensing technologies for optimum detection accuracy and to prevent unwanted alarms. Auxiliary contacts shall be provided to shut down the air handling unit fan. The detector shall output to a remote alarm indicator.
- B. Detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

2.09 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

- A. Device shall contain LED indicating light near each smoke detector that may not be readily

visible, and each sprinkler water-flow switch and valve-tamper switch. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identified, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.10 WATERFLOW SWITCHES - TAMPER SWITCHES

- A. Water flow Switches and tamper switches shall be furnished and installed by the sprinkler contractor. Refer to sprinkler drawings and specs for locations and quantities.
- B. Switches shall be addressable. Electrical contractor shall wire to fire alarm system and to exterior bell/ strobe.
- C. Switches are supplied with two contacts, one for connection to fire alarm system and one for exterior bell/ strobe.

2.11 DRY PIPE SYSTEM

- A. Furnish and install an air pressure monitoring alarm which shall provide a trouble signal if the dry pipe system air pressure falls outside its allowable range.

2.12 KITCHEN HOOD INTERLOCK

- A. Furnish and install an interlock with the Kitchen Hood Extinguishing System which shall alarm the system if the Kitchen Hood goes into alarm.

2.13 TELEPHONE AUTO DIALER

- A. Furnish and install where indicated on the drawings or required elsewhere in the specifications a digital-type telephone auto dialer. The dialer shall call and notify a preprogrammed telephone number when in the alarm mode.

2.14 MAGNETIC DOOR HOLDERS

- A. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Electromagnet shall require no more than three watts to develop 25 foot-pounds of holding force.
- B. Material and finish shall match door hardware.
- C. Units are to be rated for 24-volt AC, or DC operation.

2.15 ADDRESSABLE INTERFACE DEVICE

- A. Device shall be Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts.
- B. Integral Relay shall be capable of providing a direct signal to the elevator controller to initiate elevator recall or to a circuit-breaker shunt trip for power shutdown.

2.16 CARBON MONOXIDE DETECTOR (NEW JERSEY BOARDING FACILITIES)

- A. Digitally profiled Metal Oxide Semiconductor type sensor.
- B. 0 to 200 ppm detection range.
- C. Audible alarm (85 dB).
- D. LED indicators.
- E. White powder coat finish over steel housing.
- F. Used with monitoring module.
- G. 5,000 square foot coverage area.

2.17 ANNUNCIATOR

- A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also, duplicate manual switching functions of the FACP, including acknowledging, silencing, reset, and test.
- B. Mounting: Flush cabinet, NEMA 250, Class 1.
- C. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.18 SOUNDER BASE

- A. Audible device to which smoke detector is mounted. 94dBA average sound output is to be synchronized throughout.

2.19 EXTERIOR BELL AND STROBE

- A. Weatherproof device(s) with factory integrated audible and visible devices in a single mounting assembly. Bell shall be 24-volt (nominal) which produces 83 dB measured at 10'-0". Strobe shall be Xenon type with clear lens and rated light output of 75 candelas or as required by the local Fire Marshal. Strobe shall be provided with clear weatherproof guard for physical protection and heater system to assure operation to -40°F.

PART 3 - EXECUTION

3.01 SYSTEM OPERATION

- A. Operation of any manual or automatic device shall cause all signals and strobes to sound. The annunciator will identify the specific location of the alarm initiation. Control and contacts for the building system shall function as required. Door hold opens shall be released. Door locks will be opened.

3.02 WIRING

- A. All wiring shall be run in conduit in exposed areas or Fire Alarm MC Cable in concealed spaces and shall be installed as recommended by the system manufacturer. Provide deduct alternate for use of type FPLP plenum rated fire alarm cable.
- B. Initiating device circuits are to be Class B (two-wire using NO contact initiating devices and

- an end of line resistor).
- C. Notification appliance circuits shall have polarized devices wired in parallel and be equipped an end of line resistor.

3.03 EQUIPMENT INSTALLATION

- A. Smoke detectors indicated on the drawings shall be located in the occupied space. A similar device layout shall be duplicated above suspended ceilings and/ or below raised floors as outlined in NFPA 72 for return air plenums.
- B. Connect the FACP with a disconnect switch with lockable handle or cover. Provide circuit label as per NFPA 72 requirements.
- C. Manual Pull Stations: Mount semi-flush in recessed back boxes.
- D. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised. Connect to exterior bell/ strobe (bell/strobe only operates with water flow).
- E. Ceiling-Mounted Smoke Detectors: Not less than 0'-4" (100mm) from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30'-0" (9m) apart in any direction.
- F. Wall-Mounted Smoke Detectors: At least, 0'-4" (100mm), but not more than, 1'-0" (300mm) below the ceiling.
- G. Smoke Detectors near Air Registers: Install no closer than 5'-0" (1,520mm).
- H. Duct Smoke Detectors: Comply with manufacturer's written instructions.
1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 2. Install sampling tubes so they extend the full width of the duct.
 3. Install detectors in supply and return for all units 2,000 CFM and greater. Coordinate with mechanical documents for all units requiring detection. Note that one detector may be installed in lieu of two where directed by the authority having jurisdiction when units are between 2,000 CFM and 15,000 CFM.
- I. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- J. FACP and Auxiliary Booster Panels: Surface mount with tops of cabinets not more than 6'-0" (1,830mm) above the finished floor. Provide smoke detection for room in which the panel is located.
- K. Annunciator: Install with the top of the panel not more than 6'-0" (1,830mm) above the finished floor.
- L. Provide separate zone for each floor, not to exceed 20,000 square feet, length not to exceed 200'-0" in any direction.
- M. Provide where indicated on drawings, 15 candela horn/ strobes or strobes in non-sleeping rooms up to 20' x 20'. Provide 30 candela horn/ strobes or strobes in non-sleeping rooms up to 30' x 30'. Provide 110 candela horn/ strobes in all other spaces where indicated on drawings.
- N. Sounder bases are to be used for all smoke detectors within sleeping areas.
- O. Exterior Bell and Strobe: Install on exterior wall above the Fire Department sprinkler connection at a height of 12'-0" unless directed otherwise by the local Fire Marshal. Coordinate with fire protection contractor.
- P. For all magnetic door hold-open devices, a smoke detector is to be provided within 5'-0" of each doorway on both sides of the doorway. Coordinate with architect/ owner for magnetic door holder material, finish and mounting.

3.04 SERVICE

- A. A service contract shall be made available to the owner after the one-year warranty expires.
- B. A complete set of reproducible as-builts, showing installed wiring and color coding and wire tag notations for exact locations of all installed equipment, specific interconnections between all equipment shall be provided for the system.

3.05 TESTING

- A. Perform test of system according to procedures outlined in NFPA 72. Correct deficiencies, as necessary. Provide written record of inspections, tests, and test results in the form of a test log.

END OF SECTION