

Project Manual – Volume 3



Prepared for:

Owen J. Roberts School District

901 Ridge Road
Pottstown, PA 19465

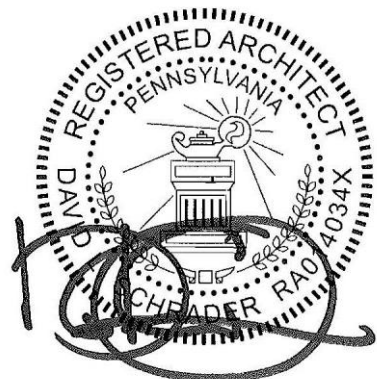
Project:

**Renovations to the Owen J. Roberts
District Services Center
932 Sanatoga Road
Pottstown, PA 19465**

Prepared by:

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Bid Documents: July 24, 2026

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PART 1 - GENERAL

1.1 FIRE UNDERWRITER SEAL:

- A. Where applicable, all material shall bear the National Board of Fire Underwriters' Seal of Approval. Certificates to this effect to be furnished to Architect upon request.

1.2 DEFINITION OF WORK RESPONSIBILITY:

- A. All electrical control components including starters required for operation of Fire Protection equipment whether integral or remote shall be furnished and installed under this Contract. Control wiring, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides the equipment. See Div. 26 specifications for starters, combination starters, and switches.
- B. Power wiring from panelboards or similar source through all equipment disconnects to motors or heating equipment shall be furnished and installed by the Electrical Contractor.
- C. Equipment disconnect switches, unless otherwise specified or supplied by the equipment supplier as an integral part of the equipment shall be furnished and installed by the Electrical Contractor.
- D. All electrical equipment, components, and wiring furnished and installed under this portion of the specifications shall conform to all requirements of the applicable portions of the electrical specifications.
- E. All base flashing, where required, shall be by the General Contractor, with necessary counter-flashing by this contractor.
- F. All structural work needed for support of Fire Protection equipment or components shall be provided by this contractor unless shown on structural plans.

1.3 RULES AND REGULATIONS:

- A. All work shall be performed in accordance with the rules and regulations of the ICC Codes, local plumbing code and ordinances, NFPA Code, and the public utilities having jurisdiction.
- B. All work shall be performed in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, and all codes and agencies having jurisdiction.
- C. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.
- D. The Owner will obtain the building permit. Any other fees relative to the contractor's work shall be paid by the contractor as part of his bid.
- E. Contractor's must be licensed within the Municipality which the project is located. Copies of these licenses must be posted within the respective job trailers during construction.

1.4 ANCHOR BOLTS:

- A. Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished under these Specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.
- B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non-shrinking cement grout.
- C. Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished under these Specifications, and must have a supervisor present at the time the foundation, bases, or curbs are poured.

1.5 DRAWINGS:

- A. The accompanying drawings are a part of these specifications and are intended to show approximate and relative locations of services and equipment. They shall not be scaled to determine exact positions, locations and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings, certain piping and duct rises, drops, offsets, valves, and related specialties are not shown. The Contractor shall provide all, piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the Owner.
- C. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to consult other trades, this Contractor shall rearrange his work at his own expense.

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT AND MATERIALS

- A. Refer to Division 1.
- B. Contractors shall include with each submittal/shop drawing, a matrix outlining all items that do not match the specified unit. If an item is not listed on the matrix, the submitted unit will be assumed to meet all parts of the specification. Contractors will be responsible to ensure that the specifications are met in full. Items in matrix shall include scheduled performance data vs. submitted performance data, specified components vs. submitted unit components, specified construction weight, warranty, etc. vs. submitted construction, weight, warranty, etc.

1.7 VISIT TO THE SITE:

- A. Prior to submission of his bid, the Contractor shall visit the site to acquaint himself with the existing conditions. Bids as submitted will be interpreted to include all costs and change made necessary by such conditions.

1.8 COORDINATION OF WORK:

- A. Contractor shall coordinate his work with that of other trades. In case of interference or problems the Architect shall decide which work is to be relocated, regardless of which is installed first.
- B. Contractor shall prepare coordination/arrangement CAD drawings for coordination with all other trades. The contractor shall furnish these coordination drawings to the contractor responsible for project BIM coordination.
- C. This Contractor shall obtain approval of all arrangement drawings before continuing with installation of his work.

1.9 LOCATION OF EQUIPMENT:

- A. All locations of fire protection equipment and associated pipe connections shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.

1.10 MATERIALS AND EQUIPMENT:

- A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, and listed/approved for their specific application.
- B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on the project. Samples shall be submitted for approval by the Architect prior to their installation.
- C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.11 WORKMANSHIP:

- A. All workmanship shall be done according to the best practices of the trade by qualified and competent tradesmen.

1.12 PROTECTION OF EQUIPMENT:

- A. Contractor shall protect all furnished material and equipment from damage until final acceptance as installed. Contractor shall temporarily seal pipe openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.
- B. Contractor shall schedule material and systems for delivery in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.
- C. Contractor shall be responsible for coordinating the procurement of specified materials and equipment being supplied by his sub-contractors and suppliers.

1.13 SCAFFOLDING AND HOISTING:

- A. Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.
- B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.14 FOREMAN:

- A. Contractor must provide a competent foreman, subject to approval of the Owner. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.
- B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.15 SLEEVES:

- A. Contractor shall furnish and set all sleeves required for the installation of the work of this section and shall be responsible for their final and permanent locations.
- B. Contractor shall fit pipes passing through masonry construction with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Unless otherwise specified or shown, sleeves shall be two pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe. Sleeves through concrete floor slabs and other partitions shall be No. 2 U.S.S. gauge sheet metal or approved equal.
- C. Where sleeves pass through foundation walls, the space between such sleeves and passing pipes shall be provided with preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.
- D. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
- E. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fire stopping material. Sleeve and sealant installation shall be UL Listed as an assembly for the required rating of the fire resistive structure. Refer to Div. 07 specifications for additional information.

1.16 CONCRETE AND MASONRY WORK:

- A. Contractor shall furnish and install all concrete bases, reinforcing, etc. required to install the work of this Division, unless otherwise noted.
- B. Prior to installing any forms, reinforcing or concrete, Contractor shall notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete. No such work shall be placed in a manner to interfere with the proper placing of the reinforcement unless so authorized by the Architect.

1.17 ESCUTCHEONS:

- A. All exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces, shall be provided with solid pattern heavy ceiling, floor or wall escutcheons with set screw. Escutcheons and plates shall be of steel or malleable iron with prime coat ready for painting. Escutcheons will not be provided where sleeves intentionally extend above finished floor.
- B. All exposed piping passing through wall or floors shall be equipped with pressed brass, chromium plated, solid-type escutcheons.

1.18 ACCESS DOORS AND PANELS:

- A. All ceiling and wall access panels not shown on the Architectural plans and required by work of this Division shall be furnished by this Contractor and set by the General Contractor. The location of these access panels must be approved by the Architect prior to their installation. The Contractor shall furnish an access panel where valves, specialties, and other serviceable items are installed behind masonry, plaster, tile, or similar type non-removable surfaces.
- B. Refer to Section 08 3113 - "Access Doors and Frames" for specific requirements.

1.19 CUTTING AND PATCHING:

- A. Each Prime Contractor shall give the General Contractor complete information as to size of openings to be provided by the General Contractor in new floors, and walls, etc., so that such openings may be provided as the project progresses.
- B. If openings are omitted or are incorrect through failure of Prime Contractors to follow these instructions, the respective Contractors shall, at their own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Architect.
- C. This Contractor shall be responsible for the cutting of existing floor slabs for the installation/demolition of any underground piping systems required by the work of this Division. The Prime Contractor is responsible for proper bedding, backfill materials and compaction (as outlined in the specifications and on the drawings) to an elevation that is level with the bottom of the existing concrete floor slab. The Prime Contractor is responsible for the patching of the floor slab, with proper materials which are equivalent to the adjacent finishes and materials. The new finished floor will be provided by the General Contractor.

- D. Cutting and patching of exposed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All holes cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials.
- E. Cutting and patching of concealed surfaces (other than the floor) of the building shall be the responsibility of each Prime Contractor as required for installation of his work. All holes cut shall be in a manner approved by the Architect. Patching of existing construction and finishes are by the Prime Contractor and must be equivalent to adjacent finishes and materials.
- F. Where it becomes necessary to cut out any portions of walls, floors, ceilings, roof or other portions of the building for the installation of work as may be required to perform and complete the work under this Contract, the Contractor shall do all necessary cutting and fitting, shall remove all excess material, and shall replace all work damaged so as to leave the entire premises in a finished condition.
- G. No cutting shall be done which may in any way affect the building structurally or architecturally. Any damage incident to cutting or other causes in the performance of this Contract shall be made good by replacement or repairs. Cutting shall be done only with the prior approval of the Architect.
- H. Contractor shall seal all piping penetrations through all walls and floors. Penetrations through fire rated walls or floors shall be sealed with an approved UL Listed fire stopping. Refer to Div. 07 for additional information

1.20 GUARANTEE:

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period as specified in Div. 01, from date of acceptance by Owner. The Contractor shall provide free service for all equipment provided under this Contract during this guarantee period.
- B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

1.21 CLEANING OF SYSTEMS:

- A. The Contractors shall thoroughly clean all pipe systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.
- B. All strainers shall be opened and cleaned thoroughly.
- C. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.22 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by the Contractor.
- B. Contractor shall furnish three copies of factory maintenance schedules for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.
- C. A representative of the manufacturer of each piece of equipment shall inspect the installation of furnished equipment, make final adjustments, and certify the equipment is properly installed and in satisfactory working condition.

1.23 SUBSTITUTIONS:

- A. Refer to Division 01 for requirements in addition to the following:
1. Various items of equipment and materials that have been used as the basis for mechanical system design have been specified by a manufacturer's name and model number. Another manufacturer's product may be submitted for consideration as a substitute. The Architect shall be the sole judge as to the comparability of an item of equipment that is submitted for approval as a substitute for that which is specified. Each of the Contractor's substitute proposals shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation. It shall be the responsibility of the Contractor to make certain that substitute equipment, which has been accepted by the Architect will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.
 2. If any changes are required in the installation of mechanical or electrical services to any mechanical equipment accepted as substitutions to the basis of design, Plumbing Contractor shall be responsible for any additional costs incurred to the Owner, Engineer, other prime contractors and costs incurred for changes to the coordination drawings

1.24 ALTERNATES:

- A. Refer to Division 01 for requirements in addition to the following:
1. Various items of equipment and materials that have been used as a basis for mechanical system design have been specified by a manufacturer's name and model number. Where another manufacturer's product has been specified as an alternate to this equipment the proposed cost for this alternate shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. The Contractor shall include such things as changes in piping, valves, supports and supporting structure, fittings, motors, controls, electrical wiring and thermal insulation. It shall be the responsibility of the Contractor to make certain the alternate equipment will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.

1.25 ALIGNMENT:

- A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to verify exact locations and alignment with the Architect in field prior to installation.
- B. The Prime Contractors shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.26 OPERATION AND MAINTENANCE INSTRUCTIONS:

- A. Refer to Division 01 for requirements in addition to the following:
 - 1. The Contractor shall prepare for the Owner, 3 hard bound volumes, each containing all operating instructions and information necessary for the care and maintenance of the system. These volumes shall be complete in every respect, and shall include detailed operating instructions for each piece of equipment and diagrams for control wiring and piping so arranged and detailed that the maintenance staff may trace the control in the event of operational malfunctioning.
 - 2. The Contractor shall submit 1 of the hard-bound volumes to the Architect for approval prior to presenting same to Owner.
 - 3. The purpose of this manual is to assist the Owner in routine operation, maintenance, servicing, troubleshooting and procurement of replacement parts. All information in the manual shall be as-built and only material pertinent to the project shall be included.
 - 4. The operating manual shall be considered a part of the final inspection and shall be submitted for approval at least 30 days in advance of a request for final inspection. The manual shall include:
 - a. A copy of all final corrected equipment submittals, control diagrams, descriptive brochures, and a list of all parts of each piece of mechanical and electrical equipment which has been furnished and installed.

5. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and troubleshooting techniques.
6. A listing of all equipment, a compilation of the nameplate data for this same equipment, the name, address and telephone number of the nearest service organization.
 - a. Copies of all A.S.M.E. pressure vessel certifications, state police approved tank permits, complete additional valve tag schedules, all electrical inspection permits and all additional mechanical and electrical permits required for occupancy by the Owner.
 - b. All of the materials shall be indexed, arranged categorically and be bound in a rigid, plastic covered, three ring binder.
7. The Contractor shall provide Project Records documents in accordance with requirements of Division 01.
8. O & M's must be provided once equipment is taken over by the Owner.
9. Warranty starts when Owner takes over that phase/space.

1.27 PAINTING:

- A. Refer to Division 07 in addition to the following:
 1. Provide corrosion inhibiting prime coating on all ferrous materials.
 2. Paint all metal laid underground with one heavy coat of corrosion protective materials.
 3. Unless specifically noted, insulation and galvanized piping in ceiling cavity area shall not be painted.

1.28 EARTHWORK:

- A. Refer to Division 31 and drawing details for requirements in addition to the following:
1. Provide all excavating, backfilling, shoring, sheeting, pumping, bailing, etc., required for the installation of the Work of this Section.
 2. Trench depths shall allow adequate cover over piping; walls shall be vertical and bottoms shall be instrument graded. Earth shall be scooped out under pipe hubs to provide a solid bearing for the barrel of the pipe on undisturbed earth. Concrete or other approved supports shall be provided for all pipes installed in fill.
 3. Carry pipe trenches in rock below the pipe invert at least 1/4 the nominal diameter of the pipe or a minimum of 4" below the bottom of the pipe whichever is the greater. Refill space below pipe with crushed stone or gravel ranging in size from 1/4" to 3/4" and compacted as indicated in Div. 33 specifications.
 4. Excavation under footings or foundations and deeper than the angle of repose from footings or foundations as determined by the Architect shall be backfilled solidly with 3,000-pound concrete, to such angle of repose and bottom of such footing or foundation. Where excavation damages existing lawns, sidewalks, roadways etc., such surfaces shall be restored to their original condition by the Contractor performing the excavation.
 5. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.
 6. Any settlement in trench backfill shall be brought to grade, and damage to pavement or slabs caused by such settlement shall be repaired at the Contractor's expense.
 7. All repair of macadam or concrete paving made necessary by work done under this contract shall be performed by General Contractor at the expense of this contractor. All such repairs shall match surrounding paving in materials and workmanship.

END OF SECTION 21 0100

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SECTION 21 0101 - REMOVALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-I Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. This Contractor shall be responsible for the removal of existing piping, sprinklers, or equipment in the existing building which is shown on the Drawings and any additional piping which is in conflict with the new construction work of all trades or new Fire Protection systems. Existing piping and sprinklers which are removed shall be disconnected at their source and capped. Furnish all labor, equipment hauling, rigging, scaffolding, etc. necessary for the removal phase of the project. Coordinate requirements with Architectural drawings.

1.3 GENERAL:

- A. Modification or removal of existing sprinklers, piping, equipment, and related accessories which require systems to be shut-down shall be coordinated with the Owner. Periods of shut-down shall be minimal and all new work shall be planned and scheduled to accomplish as few shut-downs as possible.
- B. All construction and removal work shall be performed in a manner as to keep the existing systems in operation as the work progresses. Prior to commencing construction, the contractor shall review the construction schedule with the Owner and Architect to assure a well-coordinated schedule.
- C. All existing Fire Protection sprinkler and standpipe systems (within the project scope of work and ancillary systems outside the project scope of work) shall remain functional for as long as required, until replaced with new, or reworked as required. Contractor shall provide fire watch or other fire prevention measures as required by the local AHJ and the Owner's insurance carrier during any periods where the existing system is deactivated to perform demolition or new connections at no additional cost to the owner.

- D. This contractor shall provide temporary connections where required to keep existing systems operational where required by phasing. Contractor may provide temporary isolation valves in order to keep systems functioning properly and to eliminate the need for complete system drainage every time work is performed on the existing system. All temporary isolation valves shall be removed at project completion or have handles removed and turned over to owner for safe keeping.
- E. Contractor shall be aware that some work may be required to be performed after hours, weekends, or during vacation breaks. All demolition work shall be coordinated with the Owner/Architect to limit inconvenience or interruption of the normal workday schedule for this facility.
- F. Remove as indicated on the drawings and as required for renovated areas, existing fire protection piping. Cap ends of piping which remain active. Piping which will not remain active shall be removed in its entirety (within accessible areas) or capped and abandoned in place (in inaccessible construction and below slab) unless specifically noted otherwise on the Demolition Drawings.
- G. Cutting and patching shall be by this Contractor unless otherwise indicated.
- H. Asbestos abatement will be performed by the owner's abatement contractor. Should the Contractor find any material that is suspect, he shall report this to the owner's representative immediately. The abatement contractor will schedule the material to be removed.
- I. Any demolition work done, by the Contractor, which affects the operation of this facility shall be replaced with new, repaired to original conditions or replaced by temporary means for however long as required, at no additional cost to the owner.
- J. Remove or disconnect and cap existing piping (as indicated on the drawings) serving sprinklers which are being removed.

END OF SECTION 21 0101

SECTION 21 0500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire Suppression system requirement for sprinkler systems.
- B. Piping and Fittings
- C. General Valves

1.2 RELATED REQUIREMENTS

- A. Division 09 - Painting and Coating: Preparation and painting of fire protection piping systems.
- B. Section 21 0553 - Identification for Fire Suppression Piping and Equipment: Piping identification.
- C. Section 21 1300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2010.
- C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2011.
- E. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard; 2013.
- F. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings; 2012.
- G. ASME B16.11 - Forged Fittings, Socket-welding and Threaded; 2011.
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.

- I. ASME B16.25 - Buttwelding Ends; 2012.
- J. ASME B36.10M - Welded and Seamless Wrought Steel Pipe; 2004.
- K. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).
- L. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- M. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2009 (Reapproved 2014).
- N. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- O. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2015.
- P. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2014).
- Q. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2013.
- R. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a.
- S. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- T. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015.
- U. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2012.
- V. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2012.
- W. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2009.
- X. AWWA C606 - Grooved and Shouldered Joints; 2015.
- Y. FM (AG) - FM Approval Guide; current edition.
- Z. ITS (DIR) - Directory of Listed Products; current edition.
- AA. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2016.

BB. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; 2016.

CC. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.4 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers catalogue information. Clearly indicate exact models/model number, options, and accessories to be provided. Indicate applications where the submitted product is to be used. Indicate design pressure and ratings.
- C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
 - 1. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series number.
- D. Project Record Documents: Record actual "as installed" locations of piping, sprinklers, components, and tag numbering and submit as "Record Set" after completion of all installation work.
- E. Operation and Maintenance Data: Include installation instructions and spare parts lists.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 01 - Product Requirements, for additional provisions.
 - 2. Extra Valve Stem Packings: Two for each type and size of valve.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- B. Installer and Designer Qualifications: Company specializing in performing the work of this section with minimum 5 year's experience. approved by manufacturer.
- C. Conform to UL requirements.

- D. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.
- F. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.7 EXTRA MATERIALS

- A. Provide cabinet, wrench, and spare sprinkler heads (quantities in accordance with NFPA13.)
- B. Provide two valve stem packings for each size and type of valve installed.

PART 2 - PRODUCTS

2.1 FIRE SUPPRESSION SYSTEMS

- A. Sprinkler Systems: Conform work to NFPA 13, IBC 2015, and IFC 2015, requirements of the Local A.H.J., and minimum requirements as indicated on FP Drawings and Division 21 Specifications.

2.2 BURIED PIPING

- A. Ductile Iron Pipe (3 in. and Larger): AWWA C151/A21.51 cement/mortar lined in accordance with AWWA C104/A21.4
 - 1. Fittings: AWWA C110/A21.10 standard thickness.
 - 2. Joints: AWWA C111/A21.11 rubber gasket.
 - 3. Mechanically Restrained Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.

2.3 ABOVE GROUND PIPING

- A. Acceptable Manufacturers for Piping and Tubing:
 - 1. Allied Tube - Sprinkler; 16100 S. Lathrop Avenue, Harvey, IL 60426.
 - 2. Bull Moose Tube Company, 1819 Clarkson Rd., Chesterfield, MO 63017
 - 3. Wheatland Tube Company; 900 Haddon Ave., Collingswood, NJ 08108-2162.
- B. Threaded and Welded Steel Pipe(2" and smaller): Schedule 40 Sprinkler Pipe: ASTM A795, Type E, Grade A; or Schedule 40 Pipe ASTM A-53. UL listed and FM approved for use as sprinkler piping. Black mill exterior coating and antimicrobial interior coating.
- C. Grooved Steel Pipe: Schedule 10 Sprinkler Pipe: ASTM A135, Grade A. UL listed and FM approved for use as sprinkler piping. Black mill exterior coating and antimicrobial interior coating.
- D. Fittings:
 - 1. All fittings shall be pressure rated for minimum 250 psig working pressure.
 - 2. Welded Steel Fittings: ASME B16.9, wrought steel, buttwelded, ASTM A 234/A 234M, wrought carbon steel or alloy steel, or ASME B16.5, steel flanges and fittings. Welding Materials in accordance with ASME Code.
 - 3. Threaded Malleable Iron Fittings: ASME B16.3, Class 300, threaded fittings.
 - 4. Mechanical Grooved Fittings as manufactured by Victaulic ONLY: ASTM A536 ductile iron or ASTM A53 carbon steel fittings with grooved ends designed to accept Victaulic couplings. FireLock® or standard fittings.

5. Mechanical Grooved Couplings as manufactured by Victaulic ONLY: Ductile iron housing clamps with tapered seat to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - a. Saddle type - U-bolt style hole cut Mechanical -T's shall not be permitted for use on this project. Hole cut Mechanical-T's shall be Victaulic Style 920 or 920N and installed in strict accordance with manufacturer's instructions.
 - b. Rigid Couplings: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be permitted if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations.
 - 1) 1-1/4" to 4": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic FireLock® EZ Style 009.
 - 2) 5" and Larger: Standard rigid coupling. Victaulic FireLock® Style 005 or Style 07 Zero-Flex®.
 - 3) Flexible Couplings: Use in seismic areas where required by NFPA 13.
 - (a) 2" to 6": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic Style 177 QuickVic™.
 - (b) 8" and Larger: Standard flexible coupling. Victaulic Style 75 or 77.
 - (c) Coupling gaskets shall be listed for use as follows:

- 4) Coupling gaskets shall be listed for use as follows:
 - (a) Dry System(Ambient Temperature) - FlushSeal® or EZ Style 009 design, Grade EPDM, Type A
 - (b) Dry Freezer Applications(-30°F to 0°F) - FlushSeal®, Grade L, Silicone
 - (c) Wet System(Ambient Temperature) - C-Shape or EZ Style 009 design, Grade EPDM, Type A
- c. Flanged Adapters: ASTM A536 ductile iron casting, flat faced, designed for incorporating flanged components with ANSI Class 150 bolt-hole pattern. Victaulic Style 741.

2.4 PIPE HANGERS AND SUPPORTS

- A. Acceptable Manufacturers for Piping Hangers and supports:
 - 1. TOLCO Inc.
 - 2. Grinnell
 - 3. Provide hangers and supports as manufactured by the listed acceptable manufacturers or equal as approved by owner/architect.
- B. Pipe Hangers: Adjustable swivel ring, MSS-SP-69 Type 10, Carbon steel, or Adjustable Clevis, MSS-SP-69 Type 1, Carbon steel.
 - 1. Adjustable swivel ring: TOLCO Inc. - Fig.200 or equal.
 - 2. Adjustable clevis: TOLCO Inc. - Fig.1 or equal.
 - a. Provide bolt spacer in all applications where seismic restraint is required.
- C. Armovers and end of branch: Adjustable swivel ring with surge restrainer, MSS-SP-69 Type 10
 - 1. Adjustable swivel ring: TOLCO Inc. - Fig.200 or equal w/ Fig.25 surge Restrainer
 - 2. Adjustable clevis: TOLCO Inc. - Fig.1 or equal.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Wall Support: Welded steel bracket and wrought steel clamp.

- F. Vertical Support: Steel riser clamp, MSS-SP-69 Type 8.
 - 1. Steel Riser Clamp: TOLCO Inc. - Fig.6 or equal.
- G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- H. Structural Attachments
 - 1. Reversible C-Type Beam Clamp, MSS-SP Type 19 - TOLCO Inc. Fig. 65 & Fig. 66 with Beam clamp retaining strap or equal as approved by Owner/Architect.
 - 2. Bar Joist Hanger, TOLCO Inc. Fig. 61T (up to 4" pipe)
 - 3. Threaded side Beam Bracket, TOLCO Inc. Fig. 58 (up to 4" pipe)
 - 4. Provide additional steel to support work from structural framing members as required where support is required between framing members.
- I. Victaulic Style 009, 005, and 07 rigid couplings, with angle-pattern bolt pads, may be used with IPS steel piping systems, which meet the support and hanging requirements of NFPA 13. An adequate number of Victaulic Style 177, 75 and 77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

2.5 GATE VALVES

- A. 2-1/2 inch to 8 inch:
 - 1. UL Listed FM approved, Iron body, bronze trim, , OS&Y rising stem pre-grooved for mounting tamper switch, handwheel, solid rubber covered bronze or cast iron wedge, flanged ends.
 - 2. UL Listed FM approved, ductile iron body, bronze mounted, OS&Y brass rising stem, cast iron bonnet, EPDM coated cast iron disc, handwheel, groove x groove or groove x flanged ends, optional supervisory switch. Victaulic Series 771H or Series 771F.

2.6 GLOBE OR ANGLE VALVES

- A. Up to and including 2 inches:
 - 1. Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity repackable under pressure.
- B. Over 2 inches:
 - 1. Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.7 BALL VALVES

- A. Up to and including 2 inches:
 - 1. Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, Teflon seats and stuffing box ring, lever handle and balancing stops, threaded ends with union.
- B. Over 2 inches:
 - 1. Cast steel body, chrome plated steel ball, Teflon seat and stuffing box seals, lever handle or gear drive handwheel for sizes 10 inches and over, flanged.

2.8 BUTTERFLY VALVES

- A. Bronze Body(up to 2 inches):
 - 1. UL Listed, FM approved, Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, handwheel and gear drive and integral indicating device and preinstalled supervisory switch.
 - 2. Ductile Iron Body(up to 4 inches)
 - a. UL Listed, FM approved, Ductile iron body, nickel plated ductile iron disc, Nitrile seat, Type 416 stainless steel two-piece stem, TFE-lined stainless steel bearings, weather-proof actuator with pre-wired supervisory switches. Victaulic Series 765 (365 psi) and Series 705 (300 psi).

2.9 CHECK VALVES

A. 2 inch to 3 inch:

1. UL Listed, FM approved, ductile iron body, CF8M stainless steel disc, stainless steel spring, and brass shaft, nickel-plated seat with Nitrile O-ring, grooved ends, 365 psig maximum pressure rating. Victaulic Series 717H.

B. 4 inch to 12 inch:

1. UL Listed, FM approved, ductile iron body, EPDM coated ductile iron disc, stainless steel spring and shaft, welded-in nickel seat, grooved ends, 300 psig maximum pressure rating. Victaulic Series 717.

2.10 DRAIN VALVES

A. Ball Valve:

1. UL Listed, FM approved, Brass with cap and chain, 3/4 inch hose thread.

2.11 SLEEVES:

- A. Sleeves through foundation walls shall be preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.
- B. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe.
- C. Sleeves through concrete floor slabs and other partitions shall be No. 2 U.S.S. gauge sheet metal.
- D. Unless otherwise specified or shown, sleeves shall be two pipe size larger than the overall outside diameter of the pipe when insulated.

2.12 ESCUTCHEONS:

- A. Solid pattern, heavy ceiling floor or wall escutcheons. Steel or Malleable iron with set screw. Prime coated ready for painting.
- B. Pressed brass, chromium plated, solid-type escutcheons.

2.13 ACCESS DOORS AND PANELS:

- A. Refer to Division 01 for requirements in addition to the following:
- B. Panels shall be of suitable size and construction for each specific location. All assemblies in painted wall or ceiling applications shall be rustproof and exposed finished edges and surfaces shall be prime-coated with rust inhibitive paint. All assemblies in tiled wall construction shall be stainless steel. Doors shall be flush and shall open 175 degrees on concealed hinges. Doors to be installed in ceilings shall be with screw driver operated cam locks. Doors for wall installation shall have master-keyed cylinder locks. Doors shall be Milcor, or equal, as follows:
 - 1. Construction Milcor Model
 - a. Masonry Style M
 - b. Plaster Style K

2.14 ANCHOR BOLTS:

- A. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13 and the additional requirements below.
 - 1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 2. Place hangers within 12 inches of each horizontal elbow.
 - 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 4. Support vertical piping at every other floor. Provide one riser support on each floor where grooved piping is used. Support riser piping independently of connected horizontal piping.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 6. Provide additional supports as follows:
 - a. Provide minimum of two hangers on any grooved piping exceeding 11ft. in length.
 - b. Provide additional steel as required to span structural members for intermediate support of piping required between structural framing members. ALL piping shall be supported from structural framing members only. Coordinate all work with other trades.
 - 1) Do not fasten or anchor work to concrete deck except where individually approved by Structural Engineer and Architect.
 - 2) Do not fasten or anchor any work directly to metal roof deck.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and work of other trades.
- D. Group piping whenever practical at common elevations.

- E. Provide sleeves when penetrating footings, floors, and walls and fill annular space between piping and sleeves.
 - 1. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
 - 2. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved UL Listed fireproof material. The entire penetration assembly shall be UL Listed to achieve fire resistance equivalent to fire separation required for the wall or floor.
- F. Provide escutcheons on all exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces. Escutcheons will not be required where sleeves intentionally extend above finished floor.
- G. Install valves, specialties, and other serviceable items within accessible spaces. Provide access panels where valves, specialties, and other serviceable items are required to be installed behind plaster, tile, or similar type non-removable surfaces. Coordinate panel installation with G.C. in field.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Perform welding In accordance with ASME Code.
- J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 9000.
- L. Do not penetrate building structural members unless indicated or as approved in field by Structural Engineer.
- M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- N. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- O. Provide OS&Y gate or butterfly valves for shut-off or isolating service.

- P. Provide drain valves at main shut-off valves, low points of piping and apparatus.
- Q. Provide all concrete bases, reinforcing, etc. required to install the work of this section, unless otherwise noted. Prior to installing any forms, reinforcing or concrete, notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete.
- R. Provide all necessary anchor bolts as required for the various equipment specified herein, and set in place at the time the foundations, bases, or curbs are poured. Fill all spaces between the bolt sleeves, rough foundations, bases or curbs of the equipment with one inch of non-shrinking cement grout. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

END OF SECTION 21 0500

SECTION 21 0553 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe Markers.

1.2 RELATED REQUIREMENTS

- A. Section 09 9000 - Painting and Coating: Identification painting.

1.3 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 GENERAL

- A. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or schedule. Provide numbers, lettering and working as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: (Standpipe F12)
- C. Manufacturers
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
 - 2. Brady Corporation: www.bradycorp.com.
 - 3. Brimar Industries: www.brimar.com
 - 4. Champion America, Inc: www.Champion-America.com.
 - 5. Kolbi Pipe Markers: www.kolbipipemarkers.com
 - 6. Seton Identification Products: www.seton.com/aec.

2.2 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.

2.3 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter. Minimum information indicating fluid being conveyed(FP) and FP Zone where appropriate.
- B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 - 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
- B. Stencil Paint: As specified in Section 09 9000, semi-gloss enamel, colors conforming to ASME A13.1.

2.5 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
 - 1. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

2.6 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 - 1. Sprinkler Valves: Black.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Div.1 specifications for stencil painting.

3.2 INSTALLATION

- A. Attach nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Attach tags to all valves with corrosion resistant chain.
- C. Provide additional labelling including but not limited equipment tags, room labels, etc., for location of equipment and valving as required by the Authority Having Jurisdiction. Coordinate work with Architect in field.
- D. Provide riser tags including hydraulic calculation information at all riser alarm valves and floor control assemblies.
- E. Identify equipment with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- F. Identify valves in main and branch piping with tags. Identify auxiliary drains and any piping specialty required for maintenance and operation of the system with nameplates indicating the function of the specialty.
- G. Tag automatic controls, instruments, and relays. Key to control schematic.

- H. Identify piping, concealed or exposed, with plastic pipe markers or Stencil painting (permitted within mechanical spaces). Verify requirements for exposed piping identification in finished areas with Architect in field. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification on horizontal piping not to exceed 20 feet on straight runs and at each side of penetration of structure or enclosure. Locate additional identification on risers and drops, adjacent to each Tee of main piping, and at each obstruction.
 - 1. Install plastic pipe markers in accordance with manufacturer's instructions.
 - 2. Apply stencil painting in accordance with Div. 1 specifications.
- I. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 21 0553

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SECTION 21 1300 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wet-pipe sprinkler system.
- B. System design, installation, and certification.
- C. Sprinkler Heads and Accessories
- D. Sprinkler Alarm Valves
- E. Sprinkler Pre-Action Systems
- F. Supervisory and Monitoring Devices
- G. Sprinkler System Fire Department Connections
- H. Sprinkler System Accessories and Equipment

1.2 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Fireproofing
- B. Section 21 0500 - Common Work Results for Fire Suppression.
- C. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.
- D. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- B. NFPA 13 - Standard for the Installation of Sprinkler Systems; National Fire Protection Association; 2016.
- C. IBC
- D. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.4 SUBMITTALS

- A. See Division 01 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers data on all products specified within this section including sprinklers, valves, and specialties. Clearly Indicate exact models/model numbers, options, and accessories to be provided. Indicate the application where the materials are to be used where appropriate. Manufacturers data shall include the following information as appropriate for each product: product listings (UL, FM, ASSE, etc.) performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. System Drawings:
 - 1. Contractor shall prepare drawing submittals and hydraulic calculations for submittal to the Architect/Engineer, all local reviewing agencies having jurisdiction, and the owner's insurance carrier (I.S.O submittal necessary only when required by owner's insurance carrier). The shop drawings prepared by the contractor shall bear a fire protection engineer's seal, whom is registered in the Commonwealth of Pennsylvania. No work shall begin until all approvals are granted.
 - 2. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
 - 3. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
 - 4. Submit shop drawings to authority having jurisdiction, and Fire Marshall for approval. Submit proof of approval to Architect.
 - 5. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
 - 6. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
 - 7. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

8. Maintenance Materials: Furnish the following spare equipment for Owner's use in maintenance of project.
 - a. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
 - b. Sprinkler Wrenches: For each sprinkler type.
9. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of referenced design and installation standard on site.
 1. Conform to UL requirements.
 2. Designer Qualifications: Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
 3. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
 4. Installer and Designer Qualifications: Company specializing in performing the work of this section with working knowledge of NFPA13 installation requirements with minimum 5 year's experience with fire protection systems similar to that required by this project. The
 5. Equipment and Components: Provide products that bear UL label or marking.
 6. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
 7. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.
 8. To assure uniformity and compatibility of sprinklers within the fire protection system, all sprinkler heads shall be supplied by a single manufacturer.

9. To assure uniformity and compatibility of piping specialties within the Fire Protection system, all products within each of the product families specified below shall be supplied by a single manufacturer.

1.6 PRE-DESIGN MEETING

- A. Coordinate and convene meeting before starting work of this section. Meeting shall include representation from Fire Protection Contractor, Architect, Engineer, AHJ. Meeting shall review general design requirements, submittal requirements, procedures for field coordination with Architect, and field coordination items for local AHJ review.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.8 TESTING

- A. Perform and document testing in accordance with NFPA-13, NFPA-24, and the local Authority Having Jurisdiction.
- B. Testing shall be witnessed by the local Authority Having Jurisdiction and owners representative. Coordinate scheduling of testing to allow attendance by all required representatives.

1.9 EXTRA MATERIALS

- A. Provide extra sprinklers of type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
- B. Provide suitable wrenches for each sprinkler type.
- C. Provide metal storage cabinet for spare sprinklers adjacent to main service entrance. Verify exact location with Owner Representative in field.

PART 2 - PRODUCTS

2.1 SPRINKLER SYSTEM

- A. Provide a "Design Build" Fire Suppression Sprinkler/Standpipe System in accordance with ICC (IBC) and NFPA 13&14 (latest edition), and inclusive of all additional requirements as indicated on the drawings and in these specifications. The entire building shall be "sprinklered throughout" with "Quick Response" standard coverage sprinklers. No Extended coverage heads shall be permitted except where specifically noted on the Fire Protection drawings. The Fire Suppression Sprinkler System shall be hydraulically calculated to provide the prescribed density uniformly over the most remote area in accordance with NFPA13 and include a minimum 10psi safety factor. Provide Manual Wet standpipes in all stair towers indicated on drawings
1. Occupancy: Building predominantly Light Hazard, some areas of other classification in accordance with NFPA 13 and document drawings.
 2. Water Supply:
 - a. Water supply for the sprinkler system shall be provided from the existing Fire pump/Fire Water Storage Tank located in the Fire Pump Room Below Mechanical Room M-1.
 - 1) Existing Fire Pump Rating:
 - (a) 500gpm@100psi.
 - (b) The above fire pump flow information is provided as basis of design for the contract documents. The fire protection contractor shall perform a fire pump flow test prior to preparing his hydraulic calculations and use the results of this test as the basis for design of the sprinkler system. Coordinate scheduling and performance of fire pump flow test with Owners representative.
- B. Interface system with building control system.
- C. Provide Wet Manual Standpipes with hose connection valves where indicated on the FP drawings. Provide hose connection valves within recessed Cabinets. Refer to drawings for locations.
- D. Provide Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.2 WATER FLOW TEST

- A. Perform a new water flow test before preparing hydraulic calculations and use the results of this flow test as the basis for design of the sprinkler system.
- B. Submit water flow test data with Hydraulic Calculations

2.3 SPRINKLER HEADS AND ACCESSORIES

- A. Acceptable Manufacturers
 - 1. All sprinkler heads shall be provided by from a single manufacturer.
 - 2. Viking Corporation.
 - 3. Victaulic.
 - 4. Tyco.
- B. General:
 - 1. UL and FM approved. Die-cast brass frame to 65-30, bronze upright or pendant deflector, beryllium nickel spring, with stainless steel lodgment spring and Teflon tape seal. Glycerin filled glass bulb, rated for working pressure to 175 psi . Where corrosion resistant construction is required by specifications or drawings, body shall be coated with UL listed and FM approved anti-corrosion nickel Teflon coating, (VC-250 - silver coloring). The sprinkler body shall be cast with hex shaped wrench boss to reduce the risk of damage during installation. Sprinklers can be ordered with NPT or IGS grooved connections. Sprinklers shall not contain rubber O-rings. Quick response type.
- C. Concealed Pendant Type (with matching push on escutcheon plate Suspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:
 - 1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 - 2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
 - 3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 - 4. Design Basis: Victaulic Model V38 series (Quick Response).

- D. Dry Concealed Pendant Type (with matching push on escutcheon plate Suspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
 3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 4. Galvanized steel dry barrel with stainless steel inner tube
 5. Design Basis: Victaulic Model V33 series (Quick Response).
- E. Dry, Flexible Style, Concealed Pendent/ Pendent/ Horizontal Sidewall Type (with matching push on escutcheon plate Suspended Ceiling Type for ACT, GWB, and other finished ceiling types) - Quick Response:
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
 3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 4. Flexible hose: UL listed FM approved SS braided hose
 5. Design Basis: Victaulic Model V35 series (Quick Response).

- F. Standard Upright or Pendent type, with guard (Exposed Sprinkler Areas) - Quick Response
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 2. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 3. Design Basis: Victaulic Model V27 series (Quick Response).
- G. Dry Standard Upright, with guard (Exposed Sprinkler Areas) - Quick Response
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 2. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 3. Galvanized steel dry barrel with stainless steel inner tube
 4. Design Basis: Victaulic Model V36 series (Quick Response).
- H. Dry Standard Pendant, with guard (Exposed Sprinkler Areas) - Quick Response
1. Finish: Brass. (Provide Nickel Teflon coated sprinkler heads where corrosion resistant heads are required and as noted on plans)
 2. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 3. Galvanized steel dry barrel with stainless steel inner tube
 4. Design Basis: Victaulic Model V36 series (Quick Response).

- I. Sidewall Type: Quick Response, Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
 - 1. Finish: Enamel, color as selected.
 - 2. Escutcheon Plate Finish: Enamel, color as selected by Architect. Verify color selection in field with Architect prior to order and Installation.
 - 3. Fusible Link: Glass bulb type temperature rated for specific area hazard. Contractor shall verify proper temperature selection in accordance with NFPA13 and coordination with any heat producing equipment located in close proximity to the sprinkler head.
 - 4. Design Basis: Victaulic Model V27 series (Quick Response).
- J. Dry Pendant Sprinklers (Within walk in coolers/Freezers): Quick Response, Dry pendant type with matching escutcheon plate.
 - 1. Finish: Chrome plated.
 - 2. Escutcheon Plate Finish: Chrome plated factory assembled.
 - 3. Fusible Link: Glass bulb type temperature rated for specific area hazard.
 - 4. Design Basis: Victaulic Model V36 series (Quick Response) with Integral AB6 assembly.
- K. Guards: Finish chrome.
- L. Flexible sprinkler connections: In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System [with captured coupling Style 108] may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
 - 1. Captured Coupling IGS Groove Style 108: Single-bolt, consisting of two ductile iron housings, Grade E "EPDM" gasket, and a zinc electroplated steel bolt and nut conforming to ASTM A449.
 - 2. The drop shall include a UL-2443 approved and FM-1637 listed series AH2 braided hose with bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for (5) bends at 36" length, (7) bends at 48" length, (9) bends at 60" length and be listed for (5) bends at 36" length, (7) bends at 48" length, (9) bends at 60" length and (10) bends at 72" length.

3. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed for sprinkler services to 175 psi. and FM Approved to 200 psi.
4. All hoses shall be factory-pressure tested to 400 psi.
5. AB6 Bracket Assembly, for use in cold storage applications with Victaulic Model V36 dry sprinklers.
6. Approvals:
 - a. FM-1637
 - b. UL 2443
7. Refer to the Victaulic I-VICFLEX installation manual and the Victaulic VicFlex™ Design Guide, as shown in product submittal 10.85 to ensure proper installation.

2.4 WET PIPE SPRINKLER ALARM CHECK VALVE

- A. Acceptable Manufacturers
 1. *All Alarm Valve, Riser Check Valves, and Floor Zone Control Manifold Assemblies shall be provided by from a single manufacturer.
 2. Viking Corporation.
 3. Victaulic.
 4. Tyco.
- B. Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with variable pressure trim w/pressure retard chamber, and test and drain valve. Valve internal parts shall be replaceable without removing the valve from the installed position.
 1. Design Basis: Victaulic FireLock® Series 751 w/Series 752 pressure retard chamber, and Style 720 TestMaster™ test and drain valve.

2.5 WET PIPE SPRINKLER RISER-CHECK VALVE

A. Acceptable Manufacturers

1. *All Alarm Valve, Riser Check Valves, and Floor Zone Control Manifold Assemblies
2. shall be provided by from a single manufacturer.
 - a. Viking Corporation.
 - b. Victaulic.
 - c. Tyco.

B. Check type valve with a spring-assisted, single disc design which provides a leak-free seal with as little as 5 ft/1.5 m of head. The valve shall feature a single disc mechanism incorporating a spring-assisted feature for non-slamming operation, as well as upstream and downstream pressure taps. Each valve to be factory tested to the rated working pressure.

1. Design Basis: Victaulic FireLock® Series 717R and 717HR.

2.6 FLOOR ZONE CONTROL MANIFOLD ASSEMBLY

A. Acceptable Manufacturers

1. *All Alarm Valve, Riser Check Valves, and Floor Zone Control Manifold Assemblies shall be provided by from a single manufacturer.
2. Viking Corporation.
3. Victaulic.
4. Tyco.

B. Grooved end cast iron manifold for horizontal or vertical installation, including butterfly valve with supervisory switch, check valve, flow switch, pressure gauge, and test and drain valve.

1. Design Basis: Victaulic FireLock® UMC Series

2.7 DRY PIPE SPRINKLER ALARM VALVE; WITH TEST AND DRAIN VALVE.

- A. Acceptable Manufacturers
 - 1. All Alarm Valve, Riser Check Valves, and Floor Zone Control Manifold Assemblies shall be provided by from a single manufacturer.
 - 2. Viking Corporation.
 - 3. Victaulic.
 - 4. Tyco.
- B. Grooved end valve for vertical installation only, ductile iron body, latched clapper design, aluminum bronze clapper, EPDM diaphragm and seal with brass seat and Nitrile seat O-rings. Valve internal parts shall be replaceable without removing the valve from the installed position and shall be externally resettable. Water working pressure is 300 psig in all sizes, and a minimum required 13 psig air pressure with Series 776 low pressure actuator. Valve shall be provided completely pre-trimmed as a Vic®-Quick Riser with all necessary piping, shutoff valve, pressure switches, and gages.
 - 1. Design Basis: Victaulic FireLock® Series 768 w/Series 776 low pressure actuator, pre-trimmed as a Vic®-Quick Riser with all necessary piping, shutoff valve, pressure switches, and gages.

2.8 DRY SYSTEM AIR COMPRESSOR

- A. Acceptable Manufacturers
 - 1. General Air Products
- B. Riser Mounted Air Compressor
 - 1. Fully Automatic
 - 2. Direct Drive
 - 3. Oil less piston compressor
 - 4. Magnetic Line starter
 - 5. UL Listed pressure switch
 - 6. Bubble tight air check valve
 - 7. Permanently Lubricated Bearings

8. Quiet (low Decibel) Q Series
9. Capacity: Compressor shall be sized to fill system to 40psi in 30 minutes max. in accordance with NFPA-13 (Contractor shall verify final sizing and selection based on hydraulically calculated pipe sizes and overall system volume)
10. Basis of Design:
 - a. General Air Products Model QL25050AC, 1/2 hp, 115V/1ph/60Hz (provided for basis of design only, final sizing and selection as noted above, coordinate electrical requirements with E.C. in field)

2.9 FLUSH MOUNT SPRINKLER SYSTEM FIRE DEPARTMENT CONNECTION

A. Acceptable Manufacturers

1. Potter Roemer.
2. Croker.
3. Guardian Fire Equipment

B. Type: Siamese Flush Wall Mount type.

1. Outlets: Chrome plated, flush wall mount, Siamese connections with style/threads as required by local fire department. Verify all requirements with local Fire Marshal Prior to Order/Installation Provide threaded dust cap and chain of matching material and finish.
2. Drain: 3/4 inch automatic drip. Refer to FP detail drawings for additional installation details.
3. Inlet: 4"NPT Back/Top/Bottom (as required by piping arrangement)
4. Wall Plate/Label: Polished Brass or polished chrome plated brass verify with Architect Prior to order.
 - a. Lettering: "AUTO. SPKR.. STANDPIPE". Verify all signage requirements with local Fire Marshal Prior to submittal and Order/Installation.
5. Design Basis: Potter Roemer: Model 5021-D/5022-D/5023-D

- C. Type: 5" Storz x 4"NPT Flush mounted wall type.
1. Outlets: Connections with style/threads as required by local fire department. Verify all requirements with local Fire Marshal Prior to Order/Installation Provide threaded dust cap and chain of matching material and finish.
 2. Wall Plate/Label: Polished Brass or polished chrome plated brass/"AUTO. SPKR.. STANDPIPE". Verify all signage requirements with local Fire Marshal Prior to submittal and Order/Installation.
 3. Design Basis: Potter Roemer: Model 5795-03 w/5962-B wall plate

2.10 FLUSH MOUNT BACKFLOW PREVENTER TEST CONNECTION

- A. Acceptable Manufacturers
1. Potter Roemer.
 2. Croker.
 3. Guardian Fire Equipment
- B. Type: Flush Wall Mount type.
1. Outlets: Connections 2-1/2" NST threads, 2-1/2" hose valves with caps and chains
 2. Finish: Chrome Plated
 3. Drain: 3/4 inch automatic drip.
 4. Inlet: 4"NPT Back/Top/Bottom (as required by piping arrangement
 5. Wall Plate/Label: Polished chrome plated brass (verify with Architect Prior to order)
 - a. Lettering: "TEST CONNECTION". Verify all signage requirements with local Fire Marshal Prior to submittal and Order/Installation.
 6. Design Basis: Potter Roemer: Model 5862-D(two valve)/5863-D(Three valve)/5864-D(Four Valve)

2.11 STANDPIPE HOSE CONNECTION VALVES

- A. Acceptable Manufacturers
 - 1. Potter Roemer.
 - 2. Croker.
 - 3. Guardian Fire Equipment
- B. Angle type; brass finish; 2-1/2 inch (65 mm) size, N.S.T. thread to match fire department hardware, 300 psi (2070 kPa) working pressure, with threaded cap and chain of same material and finish. Provide additional 2½"x1½" N.S.T. thread reducer with cap and chain of same material and finish.
 - 1. Design Basis: Potter Roemer: Model 4065
- C. Verify all requirements with local fire marshal and AHJ prior to order/installation.

2.12 ELECTRIC HORN/STROBE

- A. Acceptable Manufacturers
 - 1. *All electric notification devices shall be provided by from a single manufacturer.
 - 2. SimplexGrinnell.
 - 3. Wheelock.
- B. U.L. listed, Weatherproof A/V horn/strobe, red cover with white lettering, regulated 24 DC, with weatherproof mounting box.
 - 1. Design Basis: SimplexGrinnell True Alert Model 4906-9131 w/Model 4905-9828 weatherproof box.
- C. Coordinate exact location and mounting with Local AHJ and coordinate required wiring to fire alarm panel with E.C. in field.

2.13 WATER FLOW SWITCH

- A. Acceptable Manufacturers
 - 1. *All flow, pressure and supervisory switches shall be provided by from a single manufacturer.
 - 2. Potter Roemer.
 - 3. System Sensor.
- B. Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

2.14 PRESSURE SWITCH

- A. Acceptable Manufacturers
 - 1. *All flow, pressure and supervisory switches shall be provided by from a single manufacturer.
 - 2. Potter Roemer.
 - 3. System Sensor.
- B. Pressure switch for mounting in upright position, with two contacts; rated 15 amp at 125 volt AC and 2.5 amp at 30 volt DC.

2.15 SUPERVISORY SWITCH

- A. Acceptable Manufacturers
 - 1. *All flow, pressure and supervisory switches shall be provided by from a single manufacturer.
 - 2. Potter Roemer.
 - 3. System Sensor.
- B. OSY type supervisory switch, with two contacts; rated 15 amp at 125 volt AC and 2.5 amp at 30 volt DC.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design and provide fire suppression system in accordance with all referenced standards and local codes.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Provide fire hose connection stations including hose connection valve and valve cabinets as indicated on plans with sufficient clearance from walls, obstructions, or adjacent structure to allow unobstructed access to hose connection. Verify exact locations, height above floor, door swing, threads, signage, and required accessories with the Local AHJ prior to order/installation.
- D. Provide Fire Department Connections (FDC) at locations indicated on plans. Verify all Fire Department Connection details including style, connection type, height above grade, size, threads, and signage with local Fire Marshal or Fire Department prior to order/installation.
- E. Locate outside horn strobe alarm on building wall above all fire department connections, outside room containing the fire protection service entrance valving, and as indicated on plans.
- F. Place pipe runs to minimize obstruction to other work.
- G. Provide penetration firestopping for all work of Div. 21 in accordance with Div. 07 specifications.
- H. Field coordinate all exposed piping in finished spaces with Architect prior to fabrication or installation of piping. This field coordination of proposed pipe routing shall include on site review of submittal drawings with Architect and any other trades affected by the work.
- I. In areas with finished ceilings, place piping in concealed spaces above finished ceilings. Coordinate piping locations between all trades prior to installation and final design. In exposed structure areas, all pipe routing shall be reviewed in field with Architect for final approval prior to installation of any work.
- J. Center sprinklers within ACT ceilings in two directions relative to scoring and grid patterns as noted on approved architectural reflected ceiling plans. Refer to Fire Protection Details on contract drawings for additional information on centering of sprinklers within various ceiling types and patterns.

- K. Align sprinklers symmetrically with other ceiling fixtures and elements as shown on approved architectural reflected ceiling plans.
- L. Apply protective covers to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Covers shall be orange plastic with appropriate fastener for associated sprinkler type. Remove after painting. All painted sprinklers shall be replaced at no additional cost to the Owner. Coordinate work with G.C. prior to beginning any painting.
- M. Flush entire piping system of foreign matter.
- N. Install guards on all exposed sprinklers except where noted otherwise.
- O. Provide sprinkler floor control valves at locations indicated on plans. Provide butterfly shutoff valve with tamper/supervisory switch, and check valve on inlet to floor control valves. Refer to details. Provide drain riser and pipe test and drains to drain riser. Terminate drain riser to building exterior at an approved location or as otherwise indicated on plans.
- P. Provide system tests at locations as required by NFPA-13. Pipe all system test drains to building exterior in location approved by Architect , Owner , and AHJ.
- Q. Hydrostatically test entire system in accordance with NFPA-13. Coordinate testing to be witnessed by Fire Marshal and authority having jurisdiction.
- R. Provide system training for Owner representatives to include required maintenance, system supervisory devices, operating equipment, etc.
- S. Provide identification for sprinkler system components and piping in accordance with Section 210553. Provide riser tags including hydraulic calculation information at all riser alarm valves and floor control assemblies
- T. Provide laminated color coded Zone Maps to be displayed at main building fire alarm panel. Coordinate all requirements with local Fire Marshal prior to installation.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system. Coordinate work between all trades.

3.3 SCHEDULES

A. System Hazard Areas:

1. Lobby/Vestibules, Classrooms, Offices, Corridors, Library (Seating/General use areas), Game Rooms, Auditoriums, Platforms, Meeting/Conference Rooms, Toilet rooms, and similar spaces: Light Hazard.
2. Science Labs, Science Lab Prep Rooms, Mechanical Room, Storage Spaces, Janitors Closets, Commercial Kitchens, Mail Rooms, and similar spaces: Ordinary Hazard, Group 1.
3. Stages, Library (Stack areas) and similar spaces: Ordinary Hazard, Group 2.

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SECTION 22 0100 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 FIRE UNDERWRITER SEAL:

- A. Where applicable, all material shall bear the National Board of Fire Underwriters' Seal of Approval. Certificates to this effect to be furnished to Architect upon request.

1.2 DEFINITION OF WORK RESPONSIBILITY:

- A. All electrical control components including starters required for operation of Plumbing equipment whether integral or remote shall be furnished and installed under this Contract. Control wiring, conduits and accessories for control devices shall be furnished and installed by the Contractor who provides the equipment. See Division 26 specifications for starters, combination starters, and switches.
- B. Power wiring from panel boards or similar source through all equipment disconnects to motors or plumbing equipment shall be furnished and installed by the Electrical Contractor.
- C. Equipment disconnect switches, unless otherwise specified or supplied by the equipment supplier as an integral part of the equipment shall be furnished and installed by the Electrical Contractor.
- D. All electrical equipment, components, and wiring furnished and installed under this portion of the specifications shall conform to all requirements of the applicable portions of the Division 26 electrical specifications.
- E. All base flashing, where required, shall be by the General Contractor, with necessary counter-flashing by this contractor. Flashing shall comply with the requirements of Division 07.
- F. All structural work needed for support of plumbing equipment, piping, specialties, or components shall be provided by this contractor unless shown on structural plans.

1.3 RULES AND REGULATIONS:

- A. Contractor shall be licensed by the Municipality/Township in which the work is performed. Contractor is responsible for meeting all licensing requirements of the Municipality and securing all necessary certifications prior to beginning work.
- B. All work shall be performed in accordance with the rules and regulations of the ICC Codes, local plumbing codes, the utilities having jurisdiction, and the NFPA Codes.
- C. All work shall be performed in accordance with the rules and regulations or Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education (where applicable), and all codes and agencies having jurisdiction.
- D. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.
- E. Refer to Div.01 specifications for Permit application and cost responsibilities for work of this Contract.
- F. Contractor must be licensed within the Township which the project is located. Copies of these licenses must be posted within the respective job trailers during construction.

1.4 ANCHOR BOLTS:

- A. This Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished under Div. 22 specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.
- B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non-shrinking cement grout.
- C. This contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished under Div. 22 specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

1.5 DRAWINGS:

- A. The accompanying drawings are a part of these specifications and are intended to show approximate and relative locations of services and equipment. They shall not be scaled to determine exact positions, locations and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings, certain piping and duct rises, drops, offsets, valves, and related specialties are not shown. The Contractor shall provide all piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the Owner.
- C. All drawings and specifications pertaining to General Construction, Plumbing, HVAC, Electrical and other work shall be carefully examined. All work shall be coordinated prior to installation. Where physical interferences with installed work occur because of failure of this Contractor to coordinate with other trades, this Contractor shall remove and reinstall the work at his own expense.

1.6 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT AND MATERIALS

- A. Refer to Division 1 for additional submittal requirements.
- B. Contractors shall include with each submittal / shop drawing, a matrix outlining all items that do not match the specified items. If an item is not listed on the matrix, the submitted unit will be assumed to meet all parts of the specification. Contractors will be responsible to ensure that the specifications are met in full. Items in matrix shall include scheduled performance data vs. submitted performance data, specified components vs. submitted unit components, specified construction weight, warranty, etc. vs. submitted construction, weight, warranty, etc.
- C. All material submittals shall be submitted in individual submittal packages corresponding to the specification Section and Paragraph of the "Part 2 - Products" section within the applicable Div. 22 specifications for the submitted material. Submittal packages with multiple types of materials from multiple spec sections and combined into a bulk submittal package delays review time and may be rejected without review.

1.7 VISIT TO THE SITE:

- A. Prior to submission of his bid, the Contractor shall visit the site to acquaint himself with the existing conditions. Bids as submitted will be interpreted to include all costs and change made necessary by such conditions.

1.8 COORDINATION OF WORK:

- A. Contractor shall coordinate his work with that of other trades. In case of interference or problems the Architect shall decide which work is to be relocated, regardless of which is installed first.
- B. The Prime Contractor shall prepare coordination/arrangement CAD drawings for coordination with all other trades. The contractor shall furnish these coordination drawings to the contractor responsible for project BIM coordination.
- C. This Contractor shall obtain approval of all arrangement drawings before continuing with installation of his work.

1.9 LOCATION OF EQUIPMENT:

- A. All locations of plumbing, HVAC and fire protection equipment and pipe connections there to shall be verified by the Owner and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.

1.10 MATERIALS AND EQUIPMENT:

- A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.
- B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on the project. Samples shall be submitted for approval by the Architect prior to their installation.
- C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.11 WORKMANSHIP:

- A. All workmanship shall be done according to the best practices of the trade by qualified and competent tradesmen.

1.12 PROTECTION OF EQUIPMENT:

- A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.
- B. He shall schedule material and systems for deliver in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.
- C. This Contractor shall be responsible for coordinating the procurement of specified materials and equipment being supplied by his sub-contractors and suppliers.

1.13 SCAFFOLDING AND HOISTING:

- A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.
- B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.14 FOREMAN:

- A. Contractor must provide a competent foreman, subject to approval of the Owner. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours.
- B. Any instructions or notices given to the foreman shall be considered equivalent to the instruction or notices being given to the Contractor in person.

1.15 SLEEVES:

- A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.
- B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Unless otherwise specified or shown, sleeves shall be two pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight galvanized steel pipe. Sleeves through concrete floor slabs and other partitions shall be 18 ga. galvanized steel or galvanized steel pipe.
- C. Where sleeves pass through foundation walls, the space between such sleeves and passing pipes shall be caulked with graphite packing and an approved plastic and waterproof caulking compound as approved by the Architect. In lieu of caulking materials, Contractor has option of using preassembled "Link-Seals" as manufactured by Thunderline Corporation, 5495 Treadwell, Wayne, Michigan 48184.
- D. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
- E. Contractor shall seal all piping penetrations through all walls and floors. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material. Refer to Division 1 specifications for fireproofing requirements.

1.16 CONCRETE AND MASONRY WORK:

- A. The General Contractor shall furnish and install all concrete bases, reinforcing, etc. required to install the Mechanical Work, unless otherwise noted.
- B. The Contractor, prior to installing any forms, reinforcing or concrete, shall notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete. No such work shall be placed in a manner to interfere with the proper placing of the reinforcement unless so authorized by the Architect.

1.17 ESCUTCHEONS:

- A. All exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces, shall be provided with solid pattern heavy ceiling, floor or wall escutcheons with set screw. Escutcheons and plates shall be of steel or malleable iron with prime coat ready for painting. Escutcheons will not be provided where sleeves intentionally extend above finished floor.
- B. All exposed plumbing short branch connections to fixtures and/or equipment passing through wall or floors shall be equipped with pressed brass, chromium plated, solid-type escutcheons.
- C. Provide angle collars at ducts where they pass through finished walls, floors and ceilings.

1.18 ACCESS DOORS AND PANELS:

- A. All ceiling access panels not shown on the Architectural Reflected Ceiling plans and all additional wall or ceiling access panels required for access for the work of this section shall be furnished by this Contractor and set by the General Contractor. The location of these access panels must be approved by the Architect prior to their installation. The Contractor shall furnish an access panels where valves, specialties, junction boxes, and other serviceable items are installed behind plaster, tile, or similar type non-removable surfaces.
- B. Refer to Section 08 3113 - "Access Doors and Frames" for specific requirements.

1.19 CUTTING AND PATCHING:

- A. This Contractor shall give the General Contractor complete information as to size of openings to be provided by the General Contractor in new floors, and walls, etc., so that such openings may be provided as the project progresses.
- B. If openings are omitted or are incorrect through failure of this Contractor to coordinate the required openings, this Contractor shall, at his own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Architect.
- C. This Contractor shall be responsible for the cutting of existing floor slabs for the installation/demolition of any underground piping systems required by the plumbing drawings and Div. 22 specifications. This Contractor is responsible for proper bedding, backfill materials and compaction (as outlined in the specifications and on the drawings) to an elevation that is level with the bottom of the existing concrete floor slab.

- D. This Contractor shall be responsible for the cutting and patching of exposed surfaces (other than the floor) as required for the installation/demolition of any work of the plumbing drawings and Div. 22 specifications. All holes cut shall be in a manner approved by the Architect. Patching of existing construction and finishes must be equivalent to adjacent finishes and materials.
- E. Where it becomes necessary to cut out any portions of walls, floors, ceilings, roof or other portions of the building for the installation of work, and as may be required to perform and complete the work under this Contract, the Contractor shall do all necessary cutting and fitting, shall remove all excess material, and shall replace all work damaged so as to leave the entire premises in a finished condition.
- F. No cutting shall be done which may in any way affect the building structurally or architecturally. Any damage incident to cutting or other causes in the performance of this Contract shall be made good by replacement or repairs. Cutting shall be done only with the prior approval of the Architect.
- G. Contractor shall seal all piping penetrations through all walls and floors. Penetrations through fire rated walls or floors shall be sealed with an approved UL Listed fire sealant.

1.20 GUARANTEE:

- A. Refer to Div.01 specifications for Warranty requirements. Where warranty requirements are not specified in Div.01, this Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one years from date of acceptance by Owner. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period.
- B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

1.21 CLEANING OF SYSTEMS:

- A. The Contractor shall thoroughly clean all pipe systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.
- B. All strainers shall be opened and cleaned thoroughly.
- C. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.22 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.
- B. Three copies of factory maintenance schedules shall be furnished for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.
- C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

1.23 SUBSTITUTIONS:

- A. Substitutions, if permitted, must comply with the requirements of the Instruction to Bidders for pre-bid substitutions and with Division 01 Section "Product Requirements" for post-bid substitutions.
- B. Various items of equipment and materials that have been used as the basis for plumbing system design have been specified by a manufacturer's name and model number. Another manufacturer's product may be submitted for consideration as a substitute in accordance with Div. 01 requirements. The Architect/Engineer shall be the sole judge as to the comparability of an item of equipment that is submitted for approval as a substitute for that which is specified. Each substitute proposals shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. Changes required in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation, etc. shall be included. It shall be the responsibility of the Contractor to make certain that substitute equipment, which has been accepted by the Architect will fit into the designated spaces. Contractor shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.
- C. If any changes are required in the installation of mechanical or electrical services to any plumbing equipment accepted as a substitution to the basis of design, the Plumbing Contractor shall be responsible for any additional costs incurred to the Owner, Engineer, other prime contractors and costs incurred for changes to the coordination drawings

1.24 ALTERNATES:

- A. Various items of equipment and materials that have been used as a basis for plumbing system design have been specified by a manufacturer's name and model number. Where another manufacturer's product has been specified as an alternate to this equipment the proposed cost for this alternate shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports and supporting structure, fittings, ductwork, motors, controls, electrical wiring and thermal insulation. It shall be the responsibility of the contractor to make certain the alternate equipment will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.

1.25 ALIGNMENT:

- A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.
- B. This Contractor shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.26 OPERATION AND MAINTENANCE INSTRUCTIONS:

- A. Refer to Division 01 "Close-out Procedures" as well as the following.
- B. The Contractor shall prepare closeout documents in accordance with Div.01 specifications. Where not specified in Div.01 specifications, the Contractor shall prepare for the Owner, 3 hard bound volumes, each containing all operating instructions and information necessary for the care and maintenance of the system. These volumes shall be complete in every respect, and shall include detailed operating instructions for each piece of equipment and diagrams for control wiring and piping so arranged and detailed that the maintenance staff may trace the control in the event of operational malfunctioning.
- C. The Contractor shall submit 1 of the hard-bound volumes (or electronic copy) to the Architect/Engineer for approval prior to submitting same to Owner.
- D. The purpose of this manual is to assist the Owner in routine operation, maintenance, servicing, troubleshooting and procurement of replacement parts. All information in the manual shall be as-built and only material pertinent to the project shall be included.

- E. The operating manual shall be considered a part of the final inspection and shall be submitted for approval at least 30 days in advance of a request for final inspection. The manual shall include:
1. A copy of all final corrected equipment submittals, control diagrams, descriptive brochures, and a list of all parts of each piece of mechanical and electrical equipment which has been furnished and installed.
 2. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and troubleshooting techniques.
 3. A listing of all items of mechanical and electrical equipment, a compilation of the nameplate data for this same equipment, the name, address and telephone number of the nearest service organization.
 4. Copies of all A.S.M.E. pressure vessel certifications, state police approved tank permits, complete additional valve tag schedules, all electrical inspection permits and all additional mechanical and electrical permits required for occupancy by the Owner.
 5. All of the materials shall be indexed, arranged categorically and be bound in a rigid, plastic covered, three ring binder.
- F. The Contractor shall provide Project Record (As-Built) documents in accordance with requirements of Div. 01 specifications.
- G. O & M manuals must be provided prior to equipment being turned over to the Owner.
- H. Warranty period shall begin starts when Owner begins occupancy the building or related phase/area of construction.

1.27 PAINTING:

- A. Refer to Division 09 Section "Paintings and Coatings" for painting requirements as well as the following.
- B. Provide corrosion inhibiting prime coating on all ferrous materials.
- C. Paint all metal laid underground with one heavy coat of corrosion protective materials.
- D. All exposed piping, iron work, and equipment installed in the mechanical equipment rooms under this contract shall be painted 1 prime coat and 2 coats of best quality oil paint of color as selected by the Architect.

- E. All exposed gas piping within boiler rooms and mechanical rooms shall be painted yellow and identified as required in Division 22 specifications.
- F. Unless specifically noted, insulation and galvanized piping in ceiling cavity area shall not be painted.
- G. Painting of piping within exposed finished areas within the building interior shall be by the G.C. Installation of piping by the prime contractor shall include cleaning and prep of the piping for final painting by G.C.

1.28 EARTHWORK:

- A. Refer to Division 31 as well as the following.
- B. Provide all excavating, backfilling, shoring, sheeting, pumping, bailing, etc., required for the installation of the work of this Section.
- C. Trench depths shall allow adequate cover over piping, walls shall be vertical and bottoms shall be instrument graded. Earth shall be scooped out under pipe hubs to provide a solid bearing for the barrel of the pipe on undisturbed earth. Concrete or other approved supports shall be provided for all pipes installed in fill.
- D. Carry pipe trenches in rock below the pipe invert at least 1/4 the nominal diameter of the pipe or a minimum of 4" below the bottom of the pipe whichever is the greater. Backfill space below pipe with crushed stone or gravel ranging in size from 1/4" to 3/4".
- E. Excavation under footings or foundations and deeper than the angle of repose from footings or foundations as determined by the Architect shall be backfilled solidly with 3,000-pound concrete, to such angle of repose and bottom of such footing or foundation. Where excavation damages existing lawns, sidewalks, roadways etc., such surfaces shall be restored to their original condition by the Contractor performing the excavation.
- F. All excavated material remaining after the backfilling operation shall be removed from the site by this Contractor.
- G. Any settlement in trench backfill shall be brought to grade, and damage to pavement or slabs caused by such settlement shall be repaired at the Contractor's expense.

- H. All repair of macadam or concrete paving made necessary by work done under this contract shall be performed by General Contractor at the expense of this contractor. All such repairs shall match surrounding paving in materials and workmanship.

END OF SECTION 22 0100

SECTION 22 0101 - REMOVALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-I Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. This Contractor shall be responsible for the removal of existing piping, fixtures, or equipment in the existing building which is shown on the Drawings and any additional piping which is in conflict with the new construction or new Plumbing systems. Existing piping and supplies for equipment and fixtures which are removed shall be disconnected at their source and capped. Furnish all labor, equipment hauling, rigging, scaffolding, etc. necessary for the removal phase of the project. Coordinate requirements with Architectural drawings.

1.3 GENERAL:

- A. Modification or removal of existing piping, fixtures, equipment, and related accessories which require systems to be shut-down shall be coordinated with the Owner. Periods of shut-down shall be minimal and all new work shall be planned and scheduled to accomplish as few shut-downs as possible.
- B. All construction and removal work shall be performed in a manner as to keep the existing systems in operation as the work progresses. Prior to commencing construction, the contractor shall review the construction schedule with the Owner and Architect to assure a well-coordinated schedule.
- C. This contractor shall provide temporary connections where required to keep existing systems operational where required by phasing.
- D. Remove as indicated on the drawings and as required for renovated areas, existing waste, vent, water, gas, and storm water piping. Cap ends of piping which remain active. Piping which will not remain active shall be removed in its entirety (within accessible areas) or capped and abandoned in place (in inaccessible construction and below slab) unless specifically noted otherwise on the Demolition Drawings.
- E. Cutting and patching shall be by this Contractor unless otherwise indicated.

- F. Asbestos abatement will be performed by the owner's abatement contractor. Should the Contractor find any material that is suspect, he shall report this to the owner's representative immediately. The abatement contractor will schedule the material to be removed.
- G. Remove or disconnect and cap existing piping (as indicated on the drawings) serving plumbing fixtures which are being removed.
- H. Carefully disconnect all fixtures which are to be replaced with new like in kind fixtures such that the original rough in can be reused. Contractor shall replace damaged connections or rough in supplies where necessary to reconnect new fixtures. Contractor shall provide all required new hardware for mounting and reconnection of new fixtures.

END OF SECTION 22 0101

SECTION 22 0502 - EXCAVATION, BACKFILL & COMPACTION FOR UTILITY TRENCHES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Division 31 - Earthwork

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Excavation, backfill and compaction associated with utility construction including such related features as protection of adjacent utilities and structures, maintenance and protection of traffic, cutting paved surfaces, support of excavation, control of excavated materials, dewatering, piping, bedding, disposal of excavated materials, and all work related to providing all utilities and structures in connection with sanitary sewer piping.

1.3 DEFINITIONS

- A. Backfill: Stone materials or imported structural fill materials.
- B. Bedding Course: Layer placed over the excavated subgrade in a trench before laying a pipe.
- C. Utilities: Include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 SUBMITTALS

- A. Refer to Division 01 Specifications for submittal procedures
- B. Certificates: Submit certification attesting that the composition analysis of pipe embedment and select material stone backfill materials meet specification requirements.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
- B. Testing and Inspection Service: Owner shall hire an independent testing and inspection agency to perform all soil testing during earthwork operations.
- C. Testing Laboratory Qualifications: To qualify for acceptance, the testing laboratory must demonstrate to Architect's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct required field and laboratory testing without delaying the progress of the work.
- D. Testing & Inspection Agency: The Owner will provide and pay for the services of an Independent Testing & Inspection Agency who will have the responsibility of determining what subgrade is acceptable or unacceptable and must be removed by the Contractor. The imported fill or imported structural fill shall be installed and compacted under the direction and observation of the Independent Testing & Inspection Agency. The Independent Testing & Inspection Agency will also document quantities of all materials on a daily basis. The Independent Testing & Inspection Agency will also monitor other earthwork that the Owner determines.

1.6 PROJECT CONDITIONS

- A. Excavation and Rock Removal:
 - 1. General:
 - a. The Contractor shall complete the excavation as indicated on the drawings and in Division 01.
 - b. When excavation has reached required subgrade elevations, notify Architect or Independent Testing & Inspection Agency, who will make an inspection of conditions. If the Independent Testing & Inspection Agency determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as to the extent directed by the Independent Testing & Inspection Agency.
 - 2. Excavation Classifications: Refer to Division 01 and Division 31.

B. Compaction of Backfill:

1. Placing of Fill Materials: Place the specified structural fill, stone backfill and in all areas, in layers not more than 6" in loose depth for material compacted by heavy compaction equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers.
2. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.
3. Place imported structural fill, backfill and fill materials evenly adjacent to structures to required elevations. Prevent wedging action of backfill against structured by carrying material uniformly around structure to approximately same elevation in each lift.
4. Compaction: Provide fill compaction to minimum percentage of density specified for each area classification indicated below. Correct improperly compacted area or lifts as directed by Architect or Construction Manager if density tests indicated inadequate compaction.
 - a. Percentage of Maximum Density Requirements: Compact to not less than the following percentages of maximum dry density, in accordance with ASTM D 698.
 - 1) Under concrete building slabs, under concrete foundations and footings, compact each layer of imported structural fill material at 98 percent of maximum dry density. Extend compacted area beyond the exterior face of the building a distance equal to the depth of fill at that area but not less than 10 feet.
 - 2) Under exterior concrete and asphalt paving compact each layer of backfill or fill material at 98 percent of maximum dry density.
 - 3) Under lawn or unpaved areas, compact each layer of backfill or fill material at 95 percent of maximum dry density.
 - 4) At exterior face building foundation walls and walls beyond the exterior of the face of the building, each layer of backfill or fill shall be compacted to 95 percent of maximum dry density.

- 5) At asphalt and concrete paving the top 6 to 8 inches of subgrade under the paving and aggregate base course shall be compacted to 98 percent of the maximum dry density. The aggregate base course shall also be compacted to 100 percent of the maximum dry density.

C. Protection of Existing Utilities and Structures:

1. Take all precautions and utilize all facilities required to protect existing utilities and structures. In compliance with Act 199 (2004) of the General Assembly of Pennsylvania, advise each Utility at least three (3) working days in advance of intent to excavate, do demolition work and give the location of the job site. Request cooperative steps of the Utility and suggestions for procedures to avoid damage to its lines.
2. Advise each person in physical control of powered equipment used in excavation or demolition work of the type and location of utility lines at the job site, the Utility assistance to expect, and procedures to follow to prevent damage.
3. Immediately report to the Utility and the Architect any break, leak or other damage to the lines or protective coatings made or discovered during the work and immediately alert the occupants of premises of any emergency created or discovered.
4. Allow free access to Utility personnel at all times for purposes of maintenance, repair and inspection.

1.7 COLD WEATHER PROTECTION

- A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F

PART 2 PRODUCTS

2.1 PIPE BEDDING OR EMBEDMENT MATERIAL

- A. Refer to details on drawings.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Layout utility trenchwork and establish extent of excavation by area and elevation. Designate and identify datum elevation and project engineering reference points. Set required lines, levels, and elevations.
- B. Notify Architect of unexpected subsurface conditions and discontinue work in area until notified to resume work.
- C. Maintain and protect existing utilities identified by utility users within the Work area.
- D. Verify that structure walls are braced to support surcharge forces imposed by backfilling operations.

3.2 PROTECTION OF ADJACENT WORK

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Grade excavation top perimeter to prevent surface water runoff into excavation or to adjacent properties.

3.3 EXCAVATION

- A. Width of Excavation:
 - 1. Pipelines:
 - a. Excavate trenches, including laterals, to a width necessary for placement and jointing of the pipe, and for placing and compacting pipe embedment under, around and over the pipe.
 - b. Shape trench walls completely vertical from trench bottom to at least two (2) feet above the top of the pipe.
 - c. For pressure pipeline fittings, excavate trenches to a width that will permit placement of concrete thrust blocks. Provide earth surfaces for thrust blocks that are perpendicular to the direction of thrust and are free of loose or soft material.

B. Length of Open Trench:

1. Do not advance trenching operations more than 200 feet ahead of completed pipeline.

3.4 SUPPORT OF EXCAVATION

- A. Support excavations with sheeting, shoring, and bracing or in the case of pipeline construction, a "trench box" as required to comply with State, and local laws and codes.
- B. Install adequate excavation supports to prevent ground movement or settlement to adjacent structures, pipelines or utilities. Damage due to settlement because of failure to provide support or through negligence or fault of contractor in any other manner, shall be repaired at contractor's expense.
- C. Withdraw shoring, bracing, and sheeting as backfilling proceeds unless otherwise directed by the Architect.
- D. The neglect, failure or refusal of the Architect to order the use of bracing or sheeting, or a better quality, grade, or section, or larger sizes of steel or timber, or to order sheeting, bracing, struts, or shoring to be left in place, or the giving or failure to give orders or directions as to the manner or methods of placing or driving sheeting's, bracing, jacks, wales, stringers, etc., shall not in any way or to any extent relieve Contractor of any responsibility concerning the condition of excavation or of any of his obligations under the Contract, nor shall any delay, whether caused by any action or want of action on the part of Contractor, or by any act of Owner and Architect or their agents, or employees, resulting in the keeping of an excavation open longer than would otherwise have been necessary, relieve contractor from the necessity of properly and adequately protecting the excavation from caving or slipping, nor from any of their obligations under the Contract relating to injury of persons or property, nor entitle them to any claim for extra compensation.

3.5 DEWATERING

- A. Keep excavations dry and free of water. Dispose of precipitation and subsurface water clear of the work.
- B. Maintain pipe trenches dry until pipe has been jointed, inspected, and backfilled, and concrete work has been completed. Prevent trench water from entering pipelines under construction.

3.6 PIPE LAYING

- A. Provide required pipe bedding placed in accordance with the Drawing Details and Specifications.
- B. Shape recesses for the joints or bell of the pipe by hand. Assure that the pipe is supported on the lower quadrant for the entire length of the barrel.
- C. Lay pipe as specified in the appropriate Section of these Specifications for pipeline construction.

3.7 BACKFILLING EXCAVATIONS

- A. Pipeline Trench:
 - 1. After pipe installation and inspection, provide material to complete the pipe embedment in accordance with the Drawing Details and Specifications.
- B. Lift Thickness Limitations:
 - 1. Lift thicknesses shall be limited to 4 inches for pipe embedment, and 6 inches maximum for pipeline trenches within paved areas and non-paved areas and for structure excavations. In no case shall maximum lift thickness placed exceed the maximum limits specified by the manufacturer's recommendations for the compaction equipment to be utilized. Compaction equipment shall not be used over the pipe until sufficient backfill has been placed to insure that such equipment will not damage or disturb the pipe.
- C. Unsuitable Backfill Material:
 - 1. Where the Independent Testing & Inspection Agency or Architect determines backfill material to be unsuitable and rejects all or part thereof due to conditions prevailing at the time of construction, remove the unsuitable material and replace with suitable backfill material. Unsuitable material shall be legally disposed of, off-site by the contractor.

3.8 FIELD QUALITY CONTROL

- A. Quality Control testing During Construction: Contractor shall coordinate with Owner's testing laboratory to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2167 (rubber balloon method) as applicable.
 - a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.
 - b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect.
 2. Perform one test at each structure per foot of backfill and one test for each 50 lineal feet of pipe or fractions thereof, per foot of backfill.
 3. If in opinion of Architect, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained. trenching and backfilling operations with Independent Testing and Inspection Agency to perform field inspections and tests during trenchwork operations. Laboratory, inspection service, and Independent Testing & Inspection Agency shall be subject to acceptance by the Architect.

3.9 DISPOSAL OF EXCAVATED MATERIAL

- A. No excavated material shall remain after completion of backfilling. Excavated material shall be removed from the construction area, and disposed of legally, off-site.

3.10 CLEANUP

- A. Upon completion of trenchwork operations, clean areas within contract limits, remove tools and equipment. Provide site clear, clean, free of debris, and suitable for site work operations.

END OF SECTION 22 0502

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SECTION 22 0513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 REFERENCE STANDARDS

- A. ABMA STD 9 – Load Ratings and Fatigue Life for Ball Bearings
- B. IEEE 112 – IEEE Standard Test Procedures for Polyphase Induction Motors & Generators
- C. NEMA MG 1 – Motors and Generators
- D. NFPA 70 – National Electrical Code

1.3 SUBMITTALS

- A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- D. Operation Data: Include instructions for safe operating procedures.
- E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

- A. Conform to NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 40 degrees C environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- B. Provide motors with phase loss protection.
- C. Plumbing Contractor shall provide all motors that are required. Each motor shall be the correct service type and have a horsepower rating that is adequate for the device it is intended to drive. Motors shall not exceed their full load rating, including the service factor rating, whenever the driven equipment is operating at the specified capacity under normal operating conditions.

- D. Motors shall be comparable to GENERAL ELECTRIC Tri/Clad, Type K, NEMA "T" rated units or substitute equipment that is approved by the Architect/Engineer. Insulation shall be Class B. Motors shall be drip proof in dry, non-hazardous locations, weather protected where exposed to the weather or dampness, and totally enclosed, fan cooled where specified. Drip proof and totally enclosed fan cooled motors, fractional and integral horsepower, shall have service factor ratings of 1.15 and 1.0 respectively. Fractional horsepower motors shall have sealed, permanently lubricated, ball bearings unless sleeve bearings are standard with a manufacture of equipment which utilized direct driven fans. Integral horsepower motors shall have ball bearings with grease zerk fittings and drain ports. All motors shall be rated for continuous duty. Maximum temperature rise shall not exceed 40 degrees C. for drip proof frame motors and 55 degrees C. for totally enclosed motors in a 40 degree C. ambient condition. Motors shall be suitable for the electrical service specified, scheduled or shown.
- E. Motors shall have been tested and approved by the Underwriters' Laboratories, Inc. Motors shall be manufactured and classified in accordance with the current NEMA Standard Publication No. Mg 1 entitled "Motors and Generators."
- F. Motors shall be dynamically balanced and tested at the factory before shipment. They shall be relatively quiet while running. Connections to direct driven devices shall be made with a flexible coupling. Motors for V-belt drive service shall be furnished with a steel base and a screw device for adjusting belt tension.
- G. Motors shall be mounted so that they are readily accessible for maintenance. Motor terminal boxes shall be accessible. Covers shall not be blocked by other equipment. Watertight terminal boxes shall be provided on those motors in wet locations or where they are exposed to the weather. Motor mounting arrangement shall be such that the motor mounting bolts are accessible in order to facilitate its removal.
- H. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- I. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

J. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.2 MOTOR CONTROLLERS

- A. Mechanical Contractor shall provide motor controllers. The items shall be products of one manufacturer, Allen-Bradley, Square D, General Electric or Westinghouse, and shall meet latest N.E.M.A. and IEEE Specifications. Starters and contactors shall be horsepower rated. Starters shall include the proper size heater elements
- B. Magnetic starters used with pressure or float switches, thermostats or similar maintained contact switches shall be provided with "On-Off-Auto" switches on the starter.
- C. Unless otherwise noted, control and pilot devices such as electric thermostats, alternators, float controls, aquastats, etc., shall be furnished and installed by the Plumbing Contractor. Each device shall be provided with all auxiliary features and accessories which may be required for correct operation of the associated equipment.
- D. Magnetic starters shall be provided with start-stop pushbuttons on the starters unless remote control pushbuttons or other methods of starting are specified elsewhere.
- E. Unless otherwise noted elsewhere, all magnetic motor starters controlled with a remote pilot device shall contain a control circuit transformers, as an integral part of the controller, providing control power at a maximum 120 volts for the pilot device. The exact control circuit voltage shall be coordinated with the ATC supplier prior to the purchase of any motor controllers.
- F. Starters and protective devices which are provided as an integral part of the equipment furnished under the Plumbing Contracts, shall be supplied.
- G. For use in manual starting of fractional horsepower motors up to but not including 1/2 horsepower, the Plumbing Contractor shall furnish a thermal manual toggle switch type starter with pilot light specifically designed for this purpose. Each starter shall be provided with proper size heater element for the motor to be controlled. Heater elements shall be readily removable and interchangeable. Starters shall be arranged for flush or surface mounting as indicated or as required.

- H. Controllers and wiring diagrams shall be delivered to the Electrical Contractor.

2.3 MOTOR DISCONNECTS:

- A. Unless otherwise noted, motors located out of sight of their respective electric panels shall be provided with disconnect switches at the motors by the Electrical Contractor.
- B. All exhaust and supply fans on the roof shall be provided with disconnecting means at the motors as an integral part of the equipment.

2.4 ENCLOSURES:

- A. Motor controllers and disconnects shall be provided with standard approved enclosures to suit the locations in which they are installed and the conditions under which they are to operate.

2.5 MOTOR CONTROL WIRING:

- A. The Electrical Contractor shall run the power wiring system from the various supply panels indicated, to the motors and motor controllers and shall make final connections unless otherwise noted on the Drawings. The Mechanical Contractors shall run all control wiring from the motor controllers to the pilot devices.
- B. Starters, and protective control devices which are provided as integral part of the motors or motor-operated equipment shall be prewired at the factory.
- C. After final connections are completed, the Plumbing Contractor shall test each motor for proper rotation. Before applying current to the motor, the Plumbing Contractor shall check the motor for alignment, oil, etc. The Plumbing Contractor shall make any necessary adjustments to the starter and control equipment for proper starting and overload protection.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 22 0513

SECTION 22 0516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets, and swing joints.

1.2 RELATED REQUIREMENTS

- A. Section 22 1005 - Plumbing Piping.

1.3 REFERENCE STANDARDS

- A. ASTM A 269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2008.
- B. EJMA (STDS) - EJMA Standards; Expansion Joint Manufacturers Association; 2003.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- C. Design Data: Indicate selection calculations.
- D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.

- E. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
- F. Maintenance Data: Include adjustment instructions.

1.5 REGULATORY REQUIREMENTS

- A. Conform to UL requirements.

1.6 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Supply two sets of packing for each packed expansion joint.

PART 2 PRODUCTS

2.1 THERMAL EXPANSION LOOPS - COPPER PIPING

- A. Manufacturer:
 - 1. Flexicraft Industries: www.flexicraft.com
 - 2. Metraflex Company: www.metraflex.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. (2) two 90° elbows, and (1) 180° return w/drain/air release plug: Bronze
- E. Pressure Rating: 125 psi and 450 degrees F.
- F. Joint: Flanged.
- G. Size: Use pipe sized units.
- H. Offset: As calculated per application. Manufacturer to calculate and verify acceptable offset for corresponding lengths of piping served
- I. Installed in neutral position

2.2 EXPANSION LOOPS - SEISMIC/BUILDING EXPANSION JOINTS - COPPER PIPING

- A. Manufacturer:
 - 1. Flexicraft Industries: www.flexicraft.com
 - 2. Metraflex Company: www.metraflex.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. (2) two 90° elbows, and (1) 180° return w/drain/air release plug: Bronze
- E. Pressure Rating: 125 psi and 450 degrees F.
- F. Joint: Flanged.
- G. Size: Use pipe sized units.
- H. Installed in neutral position. Provide Seismic bracing as determined by seismic engineer

2.3 EXPANSION LOOPS - SEISMIC/BUILDING EXPANSION JOINTS - STEEL PIPING

- A. Manufacturer:
 - 1. Flexicraft Industries: www.flexicraft.com
 - 2. Metraflex Company: www.metraflex.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Inner Hose: Stainless Steel.
- C. Exterior Sleeve: Braided Stainless Steel.
- D. (2) two 90° elbows, and (1) 180° return w/drain/air release plug: Stainless Steel
- E. Pressure Rating: 125 psi and 450 degrees F.
- F. Joint: Flanged.
- G. Size: Use pipe sized units.

- H. Installed in neutral position. Provide Seismic bracing as determined by seismic engineer

2.4 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Manufacturers:
 - 1. Flexicraft Industries: www.flexicraft.com
 - 2. Metraflex Company: www.metraflex.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Inner Hose: Stainless Steel.
- C. Exterior Sleeve: Single braided, stainless steel.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: Threaded.
- F. Size: Use pipe sized units.
- G. Maximum offset: 1 inch on each side of installed center line.

2.5 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturer:
 - 1. Flexicraft Industries: www.mercer-rubber.com.
 - 2. Metraflex Company: www.metraflex.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: As specified for pipe joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 1 inch on each side of installed center line.

- H. Application: Copper piping.

2.6 ACCESSORIES

A. Pipe Alignment Guides:

- 1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.

B. Swivel Joints:

- 1. Bronze body, double ball bearing race, field lubricated, with rubber (Buna-N) O-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions. Refer to Plumbing details for additional requirements.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Provide Thermal Expansion fittings on all hot and hot water return piping segments exceeding 50 ft. in lengths and at intervals not to exceed 100ft. Manufacturer of expansion fittings shall provide calculations to verify suitability for individual applications.

- G. All expansion fittings for natural gas service, shall be A.G.A. certified.
- H. Provide seismic restraints in conjunction with seismically designed flexible connectors at all locations where piping crosses building seismic expansion joints.
- I. Provide nested loops where required by available space.

END OF SECTION 22 0516

SECTION 22 0553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe Markers.

1.2 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers; 2007.

1.3 SUBMITTALS

- A. Labelling List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- E. Project Record Documents: Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or schedule. Provide numbers, lettering and working as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
- B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: (Standpipe F12)
- C. Manufacturers
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
 - 2. Brady Corporation: www.bradycorp.com.
 - 3. Brimar Industries: www.brimar.com
 - 4. Champion America, Inc: www.Champion-America.com.
 - 5. Kolbi Pipe Markers: www.kolbipipemarkers.com
 - 6. Seton Identification Products: www.seton.com/aec.

2.2 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/2 inch.
 - 3. Background Color: Black.

2.3 VALVE TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black piping system abbreviation (1/4" high lettering) and sequenced valve numbers (1/2" high lettering), light contrasting background color and with 5/32" hole for fastener. Tag size minimum 1-1/2 inch diameter.
- B. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- C. Valve Schedule: Provide valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
 - 1. Frame: For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB grade sheet glass.

2.4 PIPE MARKERS

- A. Comply with ASME A13.1.
- B. Plastic Pipe Markers: Provide manufacturer's standard preprinted, flexible or semi rigid, permanent, color coded, plastic sheet pipe markers, complying with ANSI A13.1. Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
 - 1. All Piping: Provide snap-on application of pre-tensioned semi-rigid plastic full-bank pipe markers, extending 360 degrees around pipe at each location.
 - 2. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
 - 3. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastics.

2.5 UNDERGROUND PLASTIC PIPE MARKERS:

- A. Description: Manufacturer's standard 2" wide warning tape color coded and labeled to match pipe identification labels. Material shall be detectable polyester complying with ASTM B-721.

2.6 CEILING TACKS

- A. Description: Self-adhesive plastic coded dots. Color coded to match color of pipe marker.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of coverings and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment. Degrease and clean all surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Piping System Identification:

1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow:
2. Plastic pipe markers, with application system as indicated under "Products" in this section.
3. Locate pipe markers and color bands on all piping within mechanical rooms, accessible maintenance spaces, and above acoustic tile ceilings. Where piping is exposed to view in occupied/finished spaces, verify identification requirements with Architect in field prior to installation. Locate additional pipe markers in each of the following locations.
 - a. Near each valve and control device.
 - b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - d. At access doors, manholes and similar access points which permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment. On piping above removable acoustical ceilings, omit intermediately spaced markers.
4. Provide underground warning tape for all underground piping outside the building approximately 6-8 inches below finish grade.

B. Valve Identification:

1. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
2. Mount valve schedule frames and schedules in machine rooms where indicated or, of not otherwise indicated, where directed by Architect/Engineer.
3. Provide valve finder ceiling dots at all concealed valve locations. Locate on ceiling grid not on ceiling tile.

C. Mechanical Equipment Identification:

1. General: Install engraved plastic laminate nameplate on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas pressure regulators.
 - b. Tanks and pressure vessels.
 - c. Domestic water heaters
 - d. Domestic water pressure booster pumps
 - e. Recirculation pumps
 - f. Water Softeners
 - g. Sewage and Stormwater ejectors

END OF SECTION 22 0553

SECTION 22 0719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.

1.2 RELATED SECTIONS

- A. Section 078400 - Firestopping.
- B. Section 099000 - Painting and Coating: Painting insulation jacket.
- C. Section 221005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.3 REFERENCES

- A. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2004.
- B. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2005.
- C. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation; 2006.
- D. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2003.
- E. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2003.
- F. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.
- G. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- H. IECC - ICC - International Energy Conservation Code
- I. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.

1.4 SUBMITTALS

- A. See Division 01 specifications for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum THREE years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 GLASS FIBER

A. Manufacturers:

1. Knauf Fiber Glass: www.knaufusa.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.
5. Substitutions: See Section 016000 - Product Requirements.

B. Insulation: ASTM C 547 and ASTM C 795; rigid molded, noncombustible.

1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
2. Maximum service temperature: 850 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.

C. Insulation: ASTM C 547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.

1. 'K' value: ASTM C 177, 0.24 at 75 degrees F.
2. Maximum service temperature: 650 degrees F.
3. Maximum moisture absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.

E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

F. Vapor Barrier Lap Adhesive:

1. Compatible with insulation.

G. Insulating Cement/Mastic:

1. ASTM C 195; hydraulic setting on mineral wool.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Armacell International: www.armacell.com.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Type I, Tubular Grade 1; ASTM E 84/ UL 723 25/50 rated for use in return air plenums, use molded tubular material wherever possible. ArmaFlex Ultra or approved equal.
 - 1. Thermal Conductivity: 0.27 Btu-in/hr-ft²-degF @ 75 deg.F Mean Temp
 - 2. Minimum Service Temperature: -40 degrees F.
 - 3. Maximum Service Temperature: 220 degrees F.
 - 4. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 PLENUM INSULATION

- A. Manufacturer
 - 1. Unifrax Corporation
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: Fyrewrap .5 plenum insulation, high temperature, bio-soluble insulation, aluminum foil/fiberglass reinforced scrim encapsulated

2.5 JACKETS

A. PVC Plastic.

1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com.
 - b. Substitutions: See Section 016000 - Product Requirements.
2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.

B. Stainless Steel Jackets

1. Standards:
 - a. ASTM-A240 and A666 Standards
2. Thickness
 - a. .016" (.4mm)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F. For hot water piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

H. Inserts and Shields:

1. Provide shields (Piping 1 inch diameter or larger.): Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
2. Provide inserts (Piping 1 inches diameter or larger.): Between support shield and piping and under the finish jacket.
 - a. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - b. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 078400.

J. Exposed Insulated Pipe: (from finish floor level to 10 feet above finished floor): Provide with Stainless Steel jacket around entire pipe/insulation circumference

K. Provide UL listed plenum insulation on all piping not conforming to the 25/50 smoke and flame requirements for combustibility as required by the International Mechanical code, and installed within return air plenum spaces.

3.3 SCHEDULES

A. Plumbing Systems: (Provide insulation for piping and appurtenances of the following Plumbing systems as scheduled below)

1. Domestic Cold Water Supply:
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Thickness:
 - (a) All pipe sizes: 1-inch thick
 - b. Flexible Elastomeric Cellular Insulation (underground piping, piping installed in masonry walls):
 - 1) Thickness:
 - (a) All pipe sizes: 1-inch thick

2. Domestic Hot, Hot Return, 140F Hot, and 140F Return Water Supply:
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Thickness:
 - (a) Pipe sizes up to and including 1-1/4-inch: 1-inch thick
 - (b) Pipe sizes 1-1/2"-inch - 6"-inch: 1-1/2 inch thick
 - b. Flexible Elastomeric Cellular Insulation (underground piping, pipe installed in masonry walls):
 - 1) Thickness:
 - (a) Pipe sizes up to and including 1-1/4-inch: 1-inch thick
 - (b) Pipe sizes 1-1/2"-inch - 6"-inch: 1-1/2 inch thick
3. Tempered Domestic Water Supply:
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Thickness::
 - (a) All pipe sizes: 1-inch thick
4. Non-Potable Water:
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Thickness::
 - (a) All pipe sizes: 1-inch thick
 - b. Flexible Elastomeric Cellular Insulation (underground piping, pipe installed in concrete walls):
 - 1) Thickness:
 - (a) All pipe sizes: 1-inch thick

5. Roof Drain and Emergency Roof Drain Bodies:
 - a. Glass Fiber Insulation:
 - 1) 1-inch thick for Glass Fiber
 - (a) Where service is concealed Flexible Elastomeric insulation in factory color is adequate. In exposed, finished areas (i.e. gymnasium, auditorium, etc.) painted Glass Fiber with jacket is required (color selected by Architect).
6. Rainwater and Emergency Rainwater Drainage Piping Above Grade (all horizontal and all vertical piping):
 - a. Glass Fiber Insulation (w/All-Service Jacket):
 - 1) Pipe Size Range:
 - (a) all pipe sizes: 1-1/2 -inch thick
7. Cold Condensate Drains:
 - a. Flexible Elastomeric Insulation:
 - 1) 1-inch for all pipe sizes.

END OF SECTION 22 0719

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SECTION 22 1005 - PLUMBING PIPING

PART 1 - GENERAL

1.1SECTION INCLUDES

- A. Pipe, Pipe Fittings, Pipe Hangers and Supports, Valves, and Miscellaneous connections for piping systems.
 - 1. Waste/Sanitary Sewer & Vent.
 - a. Contractor shall provide complete Sanitary drainage and vent piping system as shown on plumbing drawings and specified herein including but not limited to all: piping, pipe fittings, pipe supports, pipe anchors, drains, and equipment/fixture connections including final coordination and connection to Site Sanitary system.
 - 2. Domestic Potable Water.
 - a. Contractor shall provide complete Domestic Cold, Hot, and Hot Water Return, & Tempered water piping systems as shown on plumbing drawings and specified herein including but not limited to all: equipment, piping, valves, fittings, supports, anchors, insulation, connections to equipment/fixtures and plumbing specialties including final coordination and connection to Site Water supply.
 - 3. Rainwater/Storm Water & Emergency Rainwater.
 - a. Contractor shall provide complete Rainwater/Storm water piping system as shown on plumbing drawings and specified herein including but not limited to all: piping, pipe fittings, pipe supports, pipe anchors, drains, and insulation including final connection to Site Storm water system.
 - 4. Condensate Drain Piping
 - a. Contractor shall provide complete condensate drainage piping system as shown on plumbing drawings and specified herein including but not limited to all: piping, pipe fittings, pipe supports, pipe anchors, drains, and insulation including final connection to Site Storm water system or discharge point as noted on the drawings.

1.2 RELATED REQUIREMENTS

- A. Section 07 8413 - Penetration Fireproofing
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 09 9000 - Painting and Coating.
- D. Section 22 0100 - General Provisions
- E. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.
- F. Section 22 0548 - Vibration Isolation and Seismic Mountings.
- G. Section 22 0553 - Identification for Plumbing Piping and Equipment.
- H. Section 22 0719 - Plumbing Piping Insulation.
- I. Section 22 1006 - Plumbing Piping Specialties

1.3 REFERENCE STANDARDS

- A. Work and products provided in conformance to referenced standards listed below shall be in conformance with the latest editions of the referenced standards where the standards have a revision more current than the edition noted below.
- B. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- C. ASME B16.4 - Gray Iron Threaded Fittings; The American Society of Mechanical Engineers; 1998 (R2006).
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005) (ANSI B16.18).
- E. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- F. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).
- G. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.
- H. ASTM A 74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2006.
- I. ASTM B 32 - Standard Specification for Solder Metal; 2004.

- J. ASTM B 88 - Standard Specification for Seamless Copper Water Tube; 2003.
- K. ASTM B 306 - Standard Specification for Copper Drainage Tube (DWV); 2002.
- L. ASTM C 564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2003a.
- M. ASTM D 1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2006.
- N. ASTM D 2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.
- O. ASTM D 2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings; 2007b.
- P. ASTM D 2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2004.
- Q. ASTM D 2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2008.
- R. ASTM D 2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2004.
- S. ASTM D 2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.
- T. ASTM D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2002).
- U. ASTM D 3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2006.
- V. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; American Water Works Association; 2005 (ANSI/AWWA C105/A21.5).
- W. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water; American Water Works Association; 2009 (ANSI/AWWA C151/A21.51).
- X. AWWA C651 - Disinfecting Water Mains; American Water Works Association; 2005 (ANSI/AWWA C651).
- Y. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2005.

- Z. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; Cast Iron Soil Pipe Institute; 2004.
- AA. IBC - ICC - International Building Code
- BB. IPC - ICC - International Plumbing Code
- CC. IFGC - ICC - International Fuel Gas Code
- DD. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.
- EE. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- FF. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2008.
- GG. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.
- HH. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 1996.

1.4 SUBMITTALS

- A. In addition to the requirements of Division 01 specifications, plumbing product submittals shall be in accordance with the following:
 - 1. Piping & Pipe fitting Product Data: Provide manufacturer's data on pipe materials and pipe fittings specified herein. Submittals shall clearly indicate exact materials to be provided and applications where the submitted product is to be installed and associated specification section. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.
 - 2. Hangers & Supports, Valve, & Misc. Product Data: Provide manufacturer's data for Hangers & supports, valve, & miscellaneous piping products specified herein. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.

3. Project Record Documents: Record actual locations of valves. Provide valve schedule as required in Section 22 0553 "Identification for Plumbing Piping and Equipment".
 4. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data in Maintenance Manual.
 5. Maintenance Materials: Furnish the following for Owners use in maintenance of project.
 - a. See Section 01 6000 - Product Requirements, for additional provisions.
 - b. Valve Repacking Kits: One for each type and size of valve.
- B. Review of submittals which do not clearly indicate the information noted below may be delayed or Rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review. P.C. is responsible to review plumbing product submittals provided by suppliers and coordinate and verify all submittal information prior to submission to Architect/Engineer.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Pennsylvania, UCC standards.
 1. Maintain one copy on project site.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Piping
 1. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
 2. Welder Qualifications: Certified in accordance with ASME (BPV IX) or ANSI B31.1 as applicable.
 3. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.
 4. Manufacturers: Firms regularly engaged in the manufacture of piping products of types and sizes required, and which have been in satisfactory use for not less than five years in similar service.
 5. Welding: Certify welding procedures, welders and operators in accordance with ANSI B31.1, paragraph 527.5 for shop and job site welding of piping work.

6. All grooved joint couplings, fittings, valves, and specialties shall be the products manufactured by Victaulic Co. or America. Grooving tools shall be of the same manufacturer as the grooved components.
7. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.

D. Valves: Manufacturer's name and pressure rating marked on valve body.

1. Manufacturers: Firms regularly engaged in the manufacture of valves, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five years.
2. Marking of Valves: Comply with MSS SP-25.
3. Valve Dimensions; For face-to-face and end-to-end dimensions of flanged or welding-end valve bodies, comply with ANSI B16.10. Grooved end valves shall comply with manufacturer's published dimensional data, with grooved ends complying with ANSI/AWWA C606.
4. Valve Types: Provide valves of same type by same manufacturer.

1.6 REGULATORY REQUIREMENTS

- A. Perform Work and inspections/testing in accordance with State of Pennsylvania UCC building codes including but not limited to IPC, IFGC, IBC, and IFC (Latest editions).
- B. Conform to International Plumbing Code and all requirements of the local authority having jurisdiction/local Water Authority for installation of backflow prevention devices, service valving, and metering.
- C. Submit product data for backflow prevention devices, service valving, and meters to the Municipal Water Authority prior to submission to Architect/Engineer. Obtain approval for devices and installation details and submit written approval with product data submittal to Architect/Engineer.
- D. When a meter pit is required, provide certificate of compliance from the local water authority having jurisdiction indicating approval of water meter pit construction plans prior to order/installation of water meter pit and all associated piping.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Provide factory applied plastic end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe end damage and eliminate dirt and moisture from outside of pipe and tube..
- E. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate well above grade and enclose with durable waterproof wrapping.
- F. Protect steel flanges and fittings from moisture and dirt by inside storage and enclosure or packaging with durable, waterproof wrapping.

1.8 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

1.9 EXTRA MATERIALS

- A. See Section 01 6000 - Project Requirements, for additional provisions.
- B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Except as otherwise indicated, provide factory fabricated products of the size, joint type, or class (thickness) indicated for each service. Where size, joint type, or class (thickness) is not indicated, provide products as determined by the installer for installation requirements and comply with the standards of the International Plumbing Code, International Fuel Gas Code, NFPA, Cast Iron Soil Pipe Institute (CISPI), and EPA as appropriate for each service.
- B. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 WASTE/SANITARY SEWER & VENT PIPING, BELOW SLAB/GRADE AND BURIED WITHIN 5 FEET OF BUILDING

- A. PVC Pipe: Schedule 40 ASTM D 2665 or ASTM D 3034. (No foam core permitted) - PVC Piping option for Sanitary Sewer and Waste piping systems shall not be permitted in areas with high temperature drainage discharge, these areas include but are not limited to: Kitchens, Boiler/Mechanical Rooms, etc. In areas with high temperature drainage discharge, Cast Iron Pipe shall be used in lieu of PVC piping. This cast iron pipe shall extend beyond the affected room/space to a minimum of 25ft. beyond the most downstream high temperature drain connection.
 - 1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - 2. Fittings: PVC, DWV.
 - 3. Joints: Solvent welded, with ASTM D 2564 solvent cement.

2.3 WASTE & VENT PIPING, ABOVE SLAB/GRADE

A. Cast Iron Pipe: CISPI 301, hubless.

1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe
2. Fittings: Cast iron, DWV, no-hub
3. Joints: Heavy Duty Couplings: ASTM C 1540/ASTM C 564/FM 1680 Class 1, neoprene gaskets and smooth 304 stainless steel clamp-and-shield assemblies with .010in minimum thickness corrugated shield, four clamps for sizes 1-1/2"-4", six clamps for sizes 5"-10", and worm gear drive clamps torqued to 80 inch pounds.

2.4 DOMESTIC POTABLE AND NON-POTABLE WATER PIPING, ABOVE SLAB

A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).

1. Fittings: Provide fittings from one of the options below. All fittings/components within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%) and other equivalent state regulations
 - a. Soldered Fittings (all pipe sizes): ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - b. Copper Press Fittings (all pipe sizes): Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements. fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Copper press fittings shall be manufactured by Viega and installed utilizing Rigid Tool Company as "Pro Press System" or equal system as approved by Engineer. Complete installation shall comply with manufacturers recommendations.
2. Joints: Provide pipe joints from one of the options below.
 - a. Solder Joints(All Sizes): ASTM B32, alloy Sn95 solder.
 - b. Press Fit Joints(All Sizes): ProPress (as specified above)

3. Unions (Pipe Sizes 2" and Under):
 - a. Copper tube and pipe: Class 150 bronze unions with soldered joints.
4. Flanges (Pipe Size Over 1 Inch):
 - a. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

2.5 STORM PIPING, BELOW SLAB AND BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A 74 service weight. (Provide extra heavy weight where required by local Authority Having Jurisdiction).
 1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe
 2. Fittings: Cast iron, DWV pattern
 3. Joint Seals: Hub-and-spigot, CISPI HSN compression type with ASTM C 564 neoprene gaskets conforming to ASTM C 1563, or lead and oakum.
- B. PVC Pipe: ASTM D 2665 or ASTM D 3034. (No Foam Core Permitted)
 1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Spears
 - c. Cresline
 2. Fittings: PVC, DWV pattern
 3. Joints: Solvent welded, with ASTM D 2564 solvent cement.
 4. Transition: Use appropriate transition joints as required for connection to dissimilar piping materials. Transition from PVC below grade piping to cast iron pipe above grade shall occur 6" -12" above slab.

2.6 RAINWATER & EMERGENCY RAINWATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless.
 - 1. Manufacturers:
 - a. Charlotte Pipe and Foundry
 - b. Tyler Pipe
 - 2. Fittings: Cast iron, DWV pattern
 - 3. Joints: ASTMC-1540/ASTMC-564/FM 1680 Class 1, neoprene gaskets and smooth 304 stainless steel clamp-and-shield assemblies with .010in minimum thickness corrugated shield, four clamps for sizes 1-1/2"-4", six clamps for sizes 5"-10", and worm gear drive clamps torqued to 80 inch pounds.

2.7 CONDENSATE DRAIN PIPING, BELOW SLAB

- A. PVC Pipe: ASTM D 2665 or ASTM D 3034. (No Foam Core Permitted)
 - 1. Fittings: PVC, DWV pattern
 - 2. Joints: Solvent welded, with ASTM D 2564 solvent cement.

2.8 CONDENSATE DRAIN PIPING, ABOVE SLAB

- A. Copper Pipe: Type DWV with soldered joints and fittings.

2.9 FLANGES, UNIONS, AND COUPLINGS

- A. Unions (Pipe Sizes 2" and Under):
 - 1. Ferrous pipe: Class 150 malleable iron threaded unions.
 - 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Flanges (Pipe Size Over 1 Inch):
 - 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

- C. Dielectric Unions/Connections: Provide standard products recommended by manufacturer for use in service indicated which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
1. Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier
 2. Manufacturer: Subject to compliance with requirements, provide dielectric unions of one of the following:
 - a. Atlas Products Co.
 - b. Capital Mfg. Co., Div. of Harsco Corp.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. PSI Industries.
 - f. Stockham Valves and Fittings.

2.10 MISCELLANEOUS PIPING FABRICATION MATERIALS:

- A. Forged Branch Connection Fittings: Except as otherwise indicated, provide the type as determined by the installer to comply with installation requirements.
- B. Pipe Nipples: Fabricate from same pipe as used for connected pipe; except do not use less than schedule 80 pipe where length remaining Unthreaded is less than 1 1/2", and where pipe size is less than 1 1/4", and do not thread nipples full length (no close nipples.)
- C. Copper Tube Unions: Provide standard products recommended by the manufacturer for use in the service indicated.
- D. Welding Materials: Except as otherwise indicated, provide welding materials as determined by the installer to comply with installation requirements. Comply with Section 2-C, ASME Boiler Code for welding materials.
- E. Soldering Materials: Except as otherwise indicated, provide lead free soldering materials as determined by the installer to comply with installation requirements.
- F. Tin-Antimony Solder: ASTM B32, Grade 95YA.
- G. Gaskets for Flanged Joints: ANSI B16.21 full faced for cast iron flanges; raised face for steel flanges, unless otherwise indicated.

- H. Gaskets for Grooved Joints: Pressure responsive, ASTM D-2000. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.

2.11 PIPE HANGERS AND SUPPORTS

A. HORIZONTAL PIPING HANGERS AND SUPPORTS:

1. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports of the MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information: size hangers and supports properly for piping including insulation, for insulated piping systems..
 - a. Adjustable Clevis Hangers: MSS-SP-69 Type 1, fabricated from steel. (Insulated or Non-insulated - Stationary piping systems)
 - b. Adjustable Swivel Band Hangers: MSS-SP-69 Type 10 fabricated from steel. (Non-insulated - Stationary piping systems)
 - c. Adjustable Roller Hangers: MSS-SP-69 Type 43, including axle roller and clevis.(Insulated or Non-insulated - Non-Stationary piping systems)
 - d. Steel Brackets: Welded structural steel shapes complying with one of the following:
 - 1) Light Duty: MSS Type 31.
 - 2) Medium Duty: MSS Type 32.
 - 3) Heavy Duty: MSS Type 33.

B. VERTICAL PIPING CLAMPS:

1. General: Except as otherwise indicated, provide factory fabricated vertical piping clamps of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection as determined by the installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size clamps properly for piping, including insulation (if any).
 - a. Two Bolt Riser Clamp: MSS-SP-69 Type 8.
 - b. Four Bolt Riser Clamp: MSS-SP-69 Type 42, including pipe spacers at inner bolt holes.

C. HANGER ROD ATTACHMENTS:

1. General: Except as otherwise indicated, provide factory fabricated hanger rod attachments of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by installer for installation requirements, and comply with MSS AP-69 and the manufacturer's published product information. Size attachments properly for piping, including insulation (if any).
 - a. Turnbuckles: MSS-SP-69 Type 13.
 - b. Weldless Eye Nut: MSS-SP-69 Type 17.
 - c. Malleable Eye Socket: MSS-SP-69 Type 16.
 - d. Clevises: MSS-SP-69 Type 14.

D. BUILDING ATTACHMENTS:

1. General: Except as otherwise indicated, provide factory fabricated building attachments of the MSS type and load rating indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or load rating is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published information. Size units properly for piping loading.
 - a. Concrete Inserts: MSS-SP-69 Type I8, steel.
 - b. Top Beam C-Clamps: MSS-SP-69 Type I9.
 - c. C-Clamps: MSS-SP-69 Type 23, steel
 - d. Top I-Beam Clamp: MSS-SP-69 Type 25.
 - e. Side Beam Clamp: MSS-SP-69 Type 20.
 - f. Beam Clamp/Eye Nut: MSS-SP-69 Type 28.
 - g. Wide Flange Beam Clamp/Eye Nut: MSS-SP-69 Type 29.
 - h. Beam Clamp/Extension Piece: MSS-SP-69 Type 30.

E. SADDLES AND SHIELDS:

1. General: Except as otherwise indicated, provide factory fabricated saddles and shields of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size saddles and shields properly for insulation and vapor barriers (if any).
 - a. Protection Saddles: MSS-SP-69 Type 39.
 - b. Protection Shields: MSS-SP-69 Type 40.
 - c. Wood Insulation Saddle: Provide products manufactured by Elcen Metal Products Company.

F. RESTRAINTS

1. General: Provide No-Hub Cast Iron Joint restraints as required by local Plumbing Codes, CISPI Designation 310-11, and the 2006 CISPI Installation Handbook. 24 ga. CRS, galvanized straps, stainless steel bands and worm gear drive clamps.
 - a. HoldRite Series #117

G. MISCELLANEOUS HANGER AND SUPPORT MATERIALS:

1. Metal Framing: Provide products complying with NEMA STD ML 1. Contractor shall provide all miscellaneous steel required for support of work within his contract.
2. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.
3. Cement Grout: Portland cement (ASTM C 150, Type I or Type III,) and cleaned uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with only the minimum amount of water required for placement and hydration.
4. Heavy Duty Steel trapezes: Fabricate from steel shapes selected for the loads required, weld steel in accordance with AWS Standards.
5. Pipe Guides: Provide factory fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two sections guiding spider bolted tightly to the pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of the length recommended by the manufacturer to allow indicated travel.

2.12 VALVES:

- A. General: Provide factory fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube, and equipment connections.
- B. All valves and specialties within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%), NSF/ANSI-61-8 Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372, and other equivalent state regulations.

- C. All shutoff valves 4" and smaller within the domestic potable water piping shall be full port ball valve type unless noted otherwise.
- D. General Valve Features:
1. General: Provide valves with features indicated and where not otherwise indicated, provide proper valve features as determined by installer for installation requirements. Comply with ANSI B31.1
 2. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI P16.24 (bronze).
 3. Threaded; Valve ends complying with ANSI P2.1.
 4. Grooved; Valve ends complying with ANSI/AWWA C606.
 5. Solder Joint: Valve ends complying with ANSI P16.18.
 6. Trim: Fabricate pressure-containing components of valve, including stems (shafts) and seats from bronze materials, of standard alloy recognized in the valve manufacturing industry that resists dezincification and meets the Lead free requirements
 7. Non-Metallic Discs: Non-metallic material selected for service indicated in accordance with the manufacturer's published literature.
 8. Renewable Seat: Design seat of valve with removable disc, and assemble valve so disc can be replaced when worn,
 9. Extended Stem: Increase stem length by 2" minimum, to accommodate insulation applied over valve.
 10. Check Valve: Check valve designed with hinged disc which seals against seat machined in bridge wall of valve body and manufactured for automatic closure by flow reversal.

E. BALL VALVES:

1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
 - a. Conbraco Industries, Inc.
 - b. Milwaukee Valve Co., Inc.
 - c. NIBCO, Inc.
2. General: Valves shall be rated 600 PSI non-shock CWP, valve ends shall have full depth ANSI threads or extended solder connections.
3. Comply with the following standards: MSS SP-110
4. Domestic Water: Valves shall be rated 600 PSI non-shock CWP and will have 2-pc. Lead-free bronze body and end piece, Stainless steel trim, stem and ball, PTFE seats, full port, separate pack nut with adjustable stem packing, anti-blowout stems and have the capability of accepting extended operating handles. Valve ends shall have full depth ANSI threads or extended solder connections. Valves shall be 3rd party certified to NSF/ANSI-61-8 Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372. Valves for use in insulated piping systems shall be equipped with 2" extended handles of non-thermal conductive material. A protective sleeve shall allow operation of the valve without disturbing the installation and providing a vapor seal. Product shall be NIBCO NIB-SEAL or approved equal.
 - a. Basis of Design(threaded ends): NIBCO T585HP-66-LF (1/4" to 4")
 - b. Basis of Design(Soldered): NIBCO S585HP-66-LF (1/4" to 4")
 - c. Basis of Design(PressFit): NIBCO PC-585HP-66-LF (1/4" to 4")

F. CIRCUIT SETTER BALANCING VALVES

1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
 - a. Bell & Gosset
2. Domestic Hot Water Service: Circuit Balancing Valves ½ " to 2" shall be Lead Free ball valve style. Valve shall have integral metering/test ports for flow balancing and flow measurement and be able to be pre-set to appropriate flow. Test ports shall have internal check valve and be equipped with caps. Valves shall be manufactured from dezincification resistant brass or bronze rated 240 psi at 250 F. All circuit balancing valves shall have calibrated nameplates with position indication readout and built in memory stop for repeatable regulation and control and designed for positive shutoff.
 - a. Basis of Design: Bell & Gosset ® CB - LF Series

G. SWING CHECK VALVES:

1. Acceptable Manufacturers: Subject to compliance with requirements, provide valves of one of the following:
 - a. Conbraco Industries, Inc.
 - b. Milwaukee Valve Co., Inc.
 - c. NIBCO, Inc.
2. Comply with MSS SP-71 and MSS SP-SO for design, workmanship, material and testing.
3. For Domestic Water Service: Valves shall be Y-pattern swing-type rated 200 PSI non-shock CWP. Body, bonnet, and disc hanger are to be of lead-free dezincification-resistant material and PTFE seat disc. Valve ends may be threaded or solder-type. Valves shall be 3rd party certified to NSF/ANSI-61-8 Commercial Hot 180°F (including Annex F and G) and NSF/ANSI-372.
 - a. Basis of Design: NIBCO ® T413-Y-LF (threaded); S413-Y-LF (solder)

2.13 LOW PRESSURE Y-TYPE STRAINERS:

- A. Manufacturer: Subject to compliance with requirements, provide low pressure Y-Type strainers of one of the following:
 - 1. Armstrong Machine Works.
 - 2. Hoffman Specialty, ITT Fluid Handling Div.
 - 3. Metraflex Co.
 - 4. Crane Co., Valve Div.
 - 5. Milwaukee Valve Co., Inc.
 - 6. NIBCO, Inc-
- B. General: Comply with FCI 73-1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64" perforations @ 233 per sq. in.
- C. All valves and specialties within the domestic potable water piping shall meet the Lead Free requirements of the Safe Drinking Water Act (Sec. 1417) amended 1-4-2011 (weighted average lead content = 0.25%) and other equivalent state regulations
 - 1. Threaded Ends: 2" and Smaller: Lead Free Bronze body rated for 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with threaded ball valve and pipe plug.
 - 2. Threaded Ends: Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen, with centered blowdown fitted with threaded ball valve and pipe plug.
 - 3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with threaded ball valve and pipe plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. PIPING INSTALLATION:

1. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance/ replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connection, within 1/16" misalignment tolerance.
2. Install all piping in accordance with International Plumbing Code (IPC), International Fuel Gas Code(IFGC), and ANSI B31 Code for Pressure Piping requirements as applicable to each system.
3. Provide corrosion inhibiting epoxy paint and primer on all exterior gas piping. Clean and prep piping surface prior to application. Verify color to be used with architect prior to application.

4. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanently enclosed elements of the building; limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.
5. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical equipment spaces and enclosures including elevator machine rooms.
6. Piping System Joints: Provide joints of the type indicated in each piping system.
7. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Read threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound/tape on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
8. Solder copper tube and fittings joints in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
9. Weld pipe joints in accordance with ANSI B31.
10. Flanged Joints: Match flanged within piping systems, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.
11. Insulating Unions: Comply with manufacturer's instructions for installing unions. Install unions in a manner which will prevent galvanic action and stop corrosion when joining ferrous and non-ferrous piping.

12. Grooved Joints: Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to grooved. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the job site and review and installation. Contractor shall remove and replace any joints deemed improperly installed.
13. Unless noted otherwise on the Plumbing drawings all Sanitary/Waste, Kitchen Sanitary/Kitchen Waste, Rainwater, Emergency Rainwater, and Storm piping shall be installed at a minimum continuous 2% slope (1/4" per foot).
14. Unless noted otherwise on the Plumbing drawings all Vent, Condensate Drainage, and Radon Remediation piping shall be installed at a minimum continuous 1% slope (1/8" per foot).
15. Provide penetration firestopping for all work of Div. 22 in accordance with Div. 07 specifications.

B. PIPING INSPECTION:

1. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings if any. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.
2. Disinfect water service piping in accordance with IPC or as required otherwise by local AHJ. Perform bacteriological and chemical contaminant testing in accordance with IPC and submit test results to Engineer and local AHJ.

C. PIPING TESTS:

1. General: Provide temporary equipment for testing, including pumps and gages. Test piping system before insulation is installed wherever feasible and remove control devices before testing.
2. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
3. Test piping installations and backflow preventers in accordance with IPC Section 312. Coordinate testing with local AHJ.

4. Repair piping systems sections which fail the required piping tests by disassembly and reinstallation, using new materials to the extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.

D. PIPING DISINFECTION

1. Disinfect potable water supply piping in accordance with IPC Section 610 or as required otherwise by local AHJ. Perform bacteriological and chemical contaminant testing in accordance with IPC and submit test results to Engineer and local AHJ.

E. HANGERS AND SUPPORTS:

1. Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building attachments.

F. BUILDING ATTACHMENTS INSTALLATION:

1. Install building attachments at the required locations within concrete or onto structural steel for proper piping support. Space attachments within the maximum piping span length indicated in MSS SP-69 and IPC. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the top of inserts. Prior to placing concrete, install nut in insert and screw threaded rod thru nut until rod is firmly against top of the insert body.

G. HANGERS AND SUPPORTS INSTALLATION:

1. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with the maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together with trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire of perforated metal to support piping, and do not support piping from other piping.
2. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
3. Provide additional steel as required to span structural members for intermediate support of piping required between structural framing members. ALL piping shall be supported from structural framing members only. Coordinate all work with other trades.
 - a. Do not fasten or anchor work to concrete floor deck except where individually approved by Structural Engineer and Architect.
 - b. Do not fasten or anchor any work directly to metal roof deck.
 - c. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.

d. Provisions for movement:

- 1) Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
- 2) Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- 3) Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.

e. Insulated Piping: Comply with the following installation requirements:

- 1) Saddles/Shields: Where low compressive strength insulation of vapor barriers are indicated on piping, install coated protective shields at all hanger locations.

H. PIPE GUIDE INSTALLATION:

1. Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides on each side of expansion loops.

I. PIPING ANCHORS INSTALLATION:

1. Install anchors at the proper location to prevent stresses from exceeding those permitted by ANSI B31, and to prevent the transfer of loading and stresses to connection equipment.
 - a. Fabricate and install anchor by welding steel shapes, plates and bars to the piping and to the structure. Comply with ANSI B31 and with AWS standards.
 - b. Anchor Spacings: Where not otherwise indicated, install anchors at the ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

J. ADJUSTMENT OF HANGERS AND SUPPORTS:

1. Adjust hangers and supports and place grout as required under floor mounted supports to bring piping to proper levels and elevations.

K. VALVE INSTALLATION:

1. General: Except as otherwise indicated, comply with the following requirements:
 - a. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
 - b. Install valves with stems pointed up, in the vertical position, where possible, but in no case with stems pointed downward from a horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
 - c. Insulation: Where insulation is indicated, install extended stem valves, arranged in the proper manner to receive insulation.
 - d. Applications Subject to Shock: Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.
 - e. Applications Subject to Corrosion: Do not install bronze valves and valve components in direct contact with steel, unless the bronze and steel are separated by a dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.
 - f. OS&Y Valve Stem: Select and install gate valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.
 - g. Non-Metallic Disc: Limit the selection and installation of valves with non-metallic discs to locations indicated and where foreign material in the piping system can be expected to prevent tight shut off of metal seated valves.
 - h. Renewable Seats: Select and install valves with renewable seats, except where frequent usage of the valves is indicated.

L. STRAINER INSTALLATION

1. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection, except for strainers 2" and smaller installed ahead of control valves feeding individual terminals. Where indicated, provide drain line from shutoff valve to plumbing drain, full size of blow down connection.
 2. Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:
 - a. Pumps.
 - b. Temperature control valves.
 - c. Pressure reducing valves.
 - d. Temperature or pressure regulating valves.
- M. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- N. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- O. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- P. Group piping whenever practical at common elevations.
- Q. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.
- R. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.
- S. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.
- T. Establish elevations of buried piping outside the building to ensure not less than four ft of cover.
- U. Install vent piping penetrating roofed areas to maintain integrity of roof assembly. Coordinate all requirements with roof installer. Install vent piping penetrations in existing roof assemblies in accordance with all requirements of the roof manufacturer to maintain existing roof warranty.

- V. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- W. Provide support for utility meters in accordance with requirements of utility companies.
- X. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 9000.
- Y. Install bell and spigot pipe with bell end upstream.
- Z. Install valves with stems upright or horizontal, not inverted.
- AA. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- BB. Install water piping to ASME B31.9 and IPC requirements.
- CC. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.
- DD. Sleeve pipes passing through partitions, walls and floors.

3.4 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Provide spring loaded check valves on discharge of water pumps.
- E. Provide plug valves in natural gas systems for shut-off service in piping systems larger than 2".
- F. Provide ball valves with lever handles in natural gas systems for equipment shutoff valves.
- G. Provide flow controls in water recirculating systems where indicated. Balance recirculation system to achieve timely delivery of hot water to all plumbing fixtures in accordance with IECC and local Health Department requirements.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfect water distribution system in accordance with IPC, AWWA, or other method as directed by Local A.H.J. Where sanitizing procedure is not specified by local codes follow the procedure below.
1. Prior to starting work, verify system is complete, flushed and clean.
 2. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
 3. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
 4. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
 5. Maintain disinfectant in system for 24 hours.
 6. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
 7. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
 8. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION 22 1005

SECTION 22 1006 - PLUMBING PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Backflow preventers.
- B. Cleanouts.
- C. Floor drains.
- D. Fresh air inlet
- E. Pressure reducing valves
- F. Roof Drains
- G. Shock Absorbers/Water hammer arrestors.
- H. Thermostatic mixing valves.
- I. Water Outlet Connection Box

1.2 RELATED REQUIREMENTS

- A. Section 22 0100 - General Provisions
- B. Section 22 1005 - Plumbing Piping.
- C. Section 22 3000 - Plumbing Equipment.
- D. Section 22 4000 - Plumbing Fixtures.

1.3 REFERENCE STANDARDS

- A. ASME A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers; 2001 (R2007).
- B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; The American Society of Mechanical Engineers; 2003.
- C. ASSE 1011 - Hose Connection Vacuum Breakers; American Society of Sanitary Engineering; 2004 (ANSI/ASSE 1011).

- D. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent; American Society of Sanitary Engineering; 2009 (ANSI/ASSE 1012).
- E. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers; 2011
- F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011
- G. IBC - ICC - International Building Code
- H. IPC - ICC - International Plumbing Code
- I. IFGC - ICC - International Fuel Gas Code
- J. NSF 61 - Drinking Water System Components - Health Effects; 2014 (Errata 2015)
- K. NSF 372 - Drinking Water System Components - Lead Content; 2011
- L. PDI-WH 201 - Water Hammer Arresters; Plumbing and Drainage Institute; 2006.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data for all Piping Specialty specified herein and on the Plumbing Drawings. Clearly indicate exact models/model number, options, and accessories to be provided for each product. Submittals shall clearly indicate applications where the submitted product is to be used. Manufacturer data shall indicate, material of construction, applicable standards and listings, design pressure and ratings, etc.
- C. Maintenance Data: Submit maintenance data and spare parts lists for each Piping Specialty. Include this data in Maintenance Manual.
- D. Review of submittals which do not clearly indicate the information noted above may be delayed or Rejected due to lack of clarity or information. Generic catalog sheets with no indication of options, accessories, or model to be provided will be Rejected without further review.
- E. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
- F. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors .

- G. Operation Data: Indicate frequency of treatment required for interceptors.
- H. Maintenance Data: Include installation instructions, routine maintenance instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

1.7 EXTRA MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Supply the following for Owner's use in maintenance of project:
 - 1. Two loose keys for outside hose bibbs.
 - 2. Two hose end vacuum breakers for hose bibbs.
 - 3. One service kit for each type/style and size of backflow preventer.
 - 4. One service kit for each type/style and size of pressure reducing valve.
 - 5. Two service kits for each type/style and size of hydrant/washdown box, etc.
 - 6. One replacement valve for every 10 of each type/style and size of point of use Thermostatic mixing valve
 - 7. One service kit for each type/style and size of Master Mixing Thermostatic mixing valve
 - 8. One replacement water hammer arrestor for every 10 of each type/style and size of water hammer arrestor
 - 9. One service kit for each backwater valve.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Specialties installed within Potable Water Supply Systems: Provide "Lead Free" products that comply with NSF 61 and NSF 372 for maximum lead content.

2.2 BACKFLOW PREVENTERS

- A. Manufacturers:

- 1. Ames Co. Fluid Control Systems: www.amesfirewater.com
- 2. Conbraco Industries: www.conbraco.com.
- 3. Watts Regulator Company: www.wattsregulator.com.
- 4. Wilkin/Zurn Industries, Inc: www.zurn.com.
- 5. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

- B. Double Check Backflow Preventers (1/4"-2"):

- 1. ASSE 1015; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; assembled with two quarter turn ball valves, strainer, and four test cocks.
 - a. Watts Model S-QT-LF007 or approved equal

- C. Refrigerator mounted Ice Maker/Water Dispenser Machine Connection Backflow Preventers (1/4"-1/2")

- 1. Dual Check , straight line, poppet-type construction to minimize pressure drop, all copper construction, double unions for installation, chloramine resistant materials of construction.
 - a. Watts Model LF7, or approved equal.

2.3 CLEANOUTS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company; www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. Zurn Industries, Inc.: www.zurn.com.
4. Mifab Drainage Products: www.zurn.com.
5. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. (CTG) Cleanouts to Grade (exterior areas):

1. Round, flanged cast iron housing and heavy duty scoriated cast iron cover.
2. Refer to plans for locations and details of installation.
3. Basis of design J.R. Smith Model 4250/4261 series with top finish as required by Architect:
 - a. Outlet Connection style/type to be determined by contractor.

C. (FCO) Cleanouts at Interior Finished Floor Areas:

1. Lacquered cast iron body with flashing flange, threaded ABS plug assembly, and round Nickel Bronze cover. Cover shall be scoriated in service areas, round recessed cover to accept floor finish in terrazzo and similar floor areas, and carpet marker type for units installed in carpeted areas (refer to Architectural floor finish plans for additional information).
2. Basis of design: J.R. Smith Model 4020/4031/4025 series with cover style/finish as required by final floor finish (Outlet connection type as determined by P.C)
3. Basis of design J.R. Smith Model 4100 series (Heavy Duty Traffic Areas)(Outlet connection type as determined by P.C)

D. (FCO) Cleanouts Boiler Room/Mechanical Room Floor Areas:

1. Lacquered cast iron body with anchor flange, threaded ABS plug assembly, and round Nickel Bronze cover. Cover shall be scoriated in service areas.
2. Basis of design: J.R. Smith Model 4100/4111/4105 series (Outlet connection type as determined by P.C)

- E. (FCO) Cleanouts at Interior Finished Floor Area (Resilient Sheet Flooring)
 - 1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded ABS plug assembly, and round gasketed cover with surface membrane clamp .
(See documents for additional information).
 - 2. Basis of Design: J.R. Smith Model: 4023
- F. (WCO) Cleanouts at Interior Finished Wall Areas:
 - 1. Provide Sanitary-T and extension to finish wall construction with Cleanout ferrule, threaded plug and cover. Refer to Plumbing Details for additional information.
 - 2. Cover
 - a. Finished Tile walls - Provide w/stainless steel cover
 - b. Finished painted walls - Provide with prime coated paintable steel cover
- G. Cleanouts at Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.4 FLOOR DRAINS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
 - 2. Zurn Industries, Inc: www.zurn.com.
 - 3. Josam Company: www.josam.com.
 - 4. Mifab Drainage Products: www.zurn.com.
 - 5. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. (CD-1) Floor Mounted Condensate Drain:

1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with extended anti-splash rim (mount with strainer assembly rim above finished floor elevation to prevent grey water being introduced into condensate drain system.) Provide unit with backwater valve accessory.
 - a. Deep Seal P-trap
2. Refer to drawings for locations and system sizes.
3. Basis of Design:
 - a. J.R. Smith: Model 2005-F37NB-BFV

C. (FD-1) Floor Drain - General area floor drains, toilet rooms, showers, etc.:

1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, twist-to-floor adjustable nickel bronze strainer.
 - a. Deep seal P-trap
 - b. Pro-Set "trap-guard" sewer gas prevention system.
 - c. Sediment bucket option in all shower floor drain
2. Refer to drawings for locations and system sizes.
3. Basis of Design:
 - a. J.R. Smith: Model 2005-NB with 6" round strainer, drain outlet size shall be as indicated on drawings.
 - b. Zurn: Model ZN415B with 6" round strainer, drain outlet size shall be as indicated on drawings.

2.5 FRESH AIR INLET

A. Manufacturers:

1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. Mifab Drainage Products: www.zurn.com.
4. Zurn Industries, Inc: www.zurn.com.
5. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. (FAI) Fresh Air Inlet

1. Round perforated pipe cover with Polished Nickel Bronze finish and vandal proof screws, pipe clamp with set screw
2. Basis of Design:
 - a. J.R. Smith: Model 9005.

2.6 NON FREEZE ROOF HYDRANT

A. Manufacturers:

1. Woodford: www.woodfordmfg.com
2. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. (NFRH-1) Enclosed Non-Freeze Roof Hydrants:

1. ASSE 1057, 1052; freeze resistant, self-draining with 1/8" drain piped to indirect drain receptor, dual check backflow preventer w/hose thread spout, and integral vacuum breaker/air vent, deck mounted hydrant support with underdeck clamp, 2deg. shim for pitch adjustment.
 - a. Basis of Design: Woodford Model RHY2-MS (Contractor shall pipe drain to nearest janitor room mop receptor or approved indirect waste location. Verify in field)

2.7 ROOF DRAINS AND ACCESSORIES

A. Manufacturers (for all drainage products):

1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. Mifab Drainage Products: www.zurn.com.
4. Zurn Industries, Inc: www.zurn.com.
5. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. (RD-1) Roof Drains - General Large Area Drains:

1. Refer to Architectural Drawings for locations and Plumbing drawings for connection sizes
2. Assembly: ASME A112.6.4.
3. Body: Lacquered cast iron with sump, outlet size as noted on plumbing drawings, connection style as required for connection to rainwater piping (Note: provide with threaded outlet in locations requiring quick turn outlet elbow)
4. Strainer: Removable cast iron dome with vandal proof screws.
5. Accessories: Coordinate with roofing type.
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp. (Top deck mount plate acceptable in lieu of sump receiver and under deck clamp - Contractor to indicate chosen options on submittals)
 - c. Roof sump receiver. (Top deck mount plate acceptable in lieu of sump receiver and under deck clamp - Contractor to indicate chosen options on submittals)
 - d. Waterproofing flange.
 - e. Fixed Height non-puncturing extension sleeve for built up roof insulation.(verify required extension height in field)
 - f. Quick turn elbow (where required for tight structural clearances, canopy areas etc.) JR Smith fig.# 2648S

6. Basis of Design:

- a. J.R.Smith: Model 1010-Extension-R-C-CID-1710.

C. (RD-2) Roof Drains - General Canopy Drains:

1. Refer to Architectural Drawings for locations and Plumbing drawings for connection sizes
2. Assembly: ASME A112.6.4.
3. Body: Lacquered cast iron with sump, outlet size as noted on plumbing drawings, connection style as required for connection to rainwater piping (Note: provide with threaded outlet in locations requiring quick turn outlet elbow)
4. Strainer: Removable 8-1/2 in. low profile cast iron dome with vandal proof screws.
5. Accessories: Coordinate with roofing type.
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp. (Top deck mount plate acceptable in lieu of sump receiver and under deck clamp - Contractor to indicate chosen options on submittals)
 - c. Roof sump receiver. (Top deck mount plate acceptable in lieu of sump receiver and under deck clamp - Contractor to indicate chosen options on submittals)
 - d. Waterproofing flange.
 - e. Fixed Height non-puncturing extension sleeve for built up roof insulation.(verify required extension height in field)
 - f. Quick turn elbow (where required for tight structural clearances, canopy areas etc.) JR Smith fig.# 2648S

6. Basis of Design:

- a. J.R.Smith: Model 1330-Extension-R-C-CID-1710.

2.8 SHOCK ABSORBERS/WATER HAMMER ARRESTORS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. Sioux Chief: www.sioxchief.com.
4. Zurn Industries, Inc: www.zurn.com.
5. Mifab Drainage Products.
6. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. Water Hammer Arrestors:

1. Stainless steel construction, Bellows type or Piston type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure.

2.9 THERMOSTATIC MIXING VALVES

A. Manufacturers:

1. Acorn Engineering: T/P with Paraffin actuator.
2. Powers Valves: T/P with Paraffin actuator.
3. Zurn Industries/Wilkins: (Approved For Lavatory Tempering valves)
4. Watts: (Approved For Lavatory Tempering valves)
5. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

B. Lavatory Mixing Valves:

1. Temperature and pressure regulating Under-the-Counter combination tempering valves for temperature control to ASSE 1070 down to 0.5gpm. Maximum temperature setting 110°F.
 - a. Powers Series LFE480 must be rated for minimum flow of 0.5 gpm.
 - b. Zurn; Aquaguard Model ZW3870XLT (single temp faucet), ZW3870XLT-4P (dual temp faucet)

C. Kitchen Area Handwash Sinks Mixing Valves

1. Temperature and pressure regulating combination tempering valves for temperature control to ASSE 1016-1996, 1017, 1069 and 1070 down to 0.5gpm. Temperature setting 110°F.
 - a. Powers Series LFLM495 must be rated for minimum flow of 0.5 gpm.

2.10 WATER OUTLET CONNECTION BOX

A. Manufactures:

1. Guy Gray Corporation:
2. IPS Corporation/Water-Tite: www.ipscorp.com.
3. Oatey: www.oatey.com.
4. Substitutions: Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.

B. (WCB-1) Water Connection Box (Refrigerator, Small Ice maker, Coffee, etc.)

1. Round ice maker outlet box with preloaded mounting nails and lead free valve with integral hammer arrester.
2. Valves comply with ASME A112.18.1.
3. Hammer arresters comply with ASSE 1010
 - a. Basis of Design: IPS Model AB9200HA (SWEAT)
 - b. Basis of Design: IPS Model AB9211HA (PEX-a)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all plumbing specialties in accordance with manufacturer's instructions.
- B. Roof drains
 - 1. Review Summary of Multiple Contracts for responsibilities for furnishing, and installing roof drains. Where not specifically noted otherwise in the Summary of Multiple Contract, P.C. shall furnish and install roof drains and coordinate roof drains and roof drain installation with roofing installer.
 - 2. Install roof drains in accordance with manufacturers installation instructions and in accordance with roofing manufacturer's recommendations to maintain full warranty of finished roofing installation. Coordinate all requirements with roofing installer prior to order/installation of drains.
- C. Cleanouts
 - 1. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
 - 2. Encase exterior cleanouts in concrete flush with grade.
 - 3. Install floor cleanouts and floor drains at elevation to accommodate finished floor with strainer or cover flush with finish floor.
- D. Floor drains
 - 1. Install floor drains at elevation to accommodate finished floor with strainer or cover flush with finish floor unless specifically noted otherwise.
 - 2. Provide Mechanical trap seal protection similar to ProSet Trapguards at all floor drain locations. Where required by Authority Having Jurisdiction, provide trap primers, trap primer connection on drain, and all associated piping to connect trap primer to drain.

E. Backflow preventers

1. Install approved potable water protection devices on plumbing lines as indicated on drawings and where contamination of domestic water may occur; including boiler makeup water lines, chemical mixers within janitor rooms, fire sprinkler systems, irrigation systems, flush valves, interior and exterior hose bibbs. Additional backflow prevention is not required when the connected equipment is provided with integral backflow prevention in accordance with the International Plumbing Code and the equipment is permanently/directly connected to the water supply.
2. Install all backflow preventers in easily accessible location to permit annual testing and maintenance max. 48" above finish floor.
3. Provide pressure gauges on inlet and outlet piping of all backflow preventers.
4. Pipe relief from all RPZ backflow preventers air gap drain fittings to nearest floor drain or approved discharge location.

F. Shock Absorbers / Water Hammer Arrestors

1. Provide water hammer arrestors complete with accessible isolation valve on water supply piping serving with fast closing valves with flow exceeding .5gpm and flush valves (including but not limited to washing machine connection, urinals, and water closet flush valves). Water hammer arrestors shall be sized and located in accordance with PDI guidelines.

G. Thermostatic Mixing Valves

1. Install all mixing valves in strict accordance with all manufacturers recommendations and piping installation requirements.
2. Install mixing valves at the proper ASSE rating and capacities where indicated on the drawings and details. Provide mixing valves as specified above at all lavatory and handwash sink locations.

END OF SECTION 22 1006

SECTION 22 3000 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Domestic Hot Water Circulators.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Indicate pump type, capacity, power requirements.
 - 2. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 3. Provide electrical characteristics and connection requirements.
- B. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
- C. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.5 EXTRA MATERIALS

- A. See Div. 01 specifications, for additional provisions.
- B. Provide all required maintenance parts for up to 1 yr. for all required regular maintenance

1.6 OWNER INSTRUCTION/DEMONSTRATION

- A. Provide owner instruction and demonstration for all pieces of installed equipment. Demonstration shall include: regular operating instructions, required regular maintenance, regular required maintenance schedule for each piece of equipment. P.C. shall employ the service of a manufacturer's representative where necessary or where otherwise noted in these specifications.

PART 2 PRODUCTS

2.1 DOMESTIC HOT WATER CIRCULATOR PUMPS - IN LINE

- A. Manufacturers:
 - 1. Armstrong
 - 2. Grundfos
 - 3. Thrush
 - 4. Other acceptable manufacturers offering equivalent products as approved by Architect/Engineer/Owner. Refer to Division 01 specifications for additional information.
- B. Casing: Lead Free Bronze or Stainless Steel rated for 125 psig working pressure, with stainless steel rotor assembly.
- C. Impeller: 30% glass-filled Noryl or Bronze.
- D. Shaft: Stainless steel w/permanently lubricated stainless steel bearings
- E. Seal: Silicon-Carbide rotating against a stationary ceramic seat.
- F. Gaskets: EPDM
- G. Controls: Programmable timer and Aquastat(provide programmable timer only as required by local AHJ)

H. Performance:

1. Refer to Plumbing Detail drawings for pump sizes and requirements

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping and related electrical work/fuel piping for each piece of equipment to achieve operating system
- C. Provide Concrete housekeeping base of sufficient size for all floor mounted equipment. Concrete bases shall be dowelled into floor decking. Coordinate all work with G.C. in field.
- D. Domestic Hot Water Recirculation Pumps
 1. Refer to Plumbing details for pump installation information and associated piping accessories.
 2. Provide main circuit setter valve set to specified flow for each hot water recirculation system. Balance hot water recirculation system at all balancing valve and circuit setter valve locations to achieve timely delivery of hot water to all fixtures in accordance with IECC and local Health Department requirements.
 3. Install circulation pumps in orientation as required by manufacturers recommendations.
 4. Coordinate power wiring to pump and aquastat controls with E.C. in field.

END OF SECTION 22 3000

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SECTION 22 4000 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. (LAV) Lavatories.
- B. (SINK) Sinks.
- C. (WC) Water Closets.

1.2 RELATED REQUIREMENTS

- A. Division 01 Specifications
- B. Section 07 9005 - Joint Sealers: Seal fixtures to walls and floors.
- C. Section 22 1005 - Plumbing Piping.
- D. Section 22 1006 - Plumbing Piping Specialties.
- E. Section 22 3000 - Plumbing Equipment.

1.3 REFERENCE STANDARDS

- A. ANSI Z358.1 - American National Standard for Emergency Eyewash and Shower Equipment; 2004.
- B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2006.
- C. ARI 1010 - Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers; Air-Conditioning and Refrigeration Institute; 2002.
- D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; The American Society of Mechanical Engineers; 1997 (Reaffirmed 2002).
- E. ASME A112.18.1 - Plumbing Supply Fittings; The American Society of Mechanical Engineers; 2005.
- F. ASME A112.19.2 - Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals; The American Society of Mechanical Engineers; 2008.

- G. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; The American Society of Mechanical Engineers; 2008.
- H. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals; The American Society of Mechanical Engineers; 2005.
- I. IBC - ICC - International Building Code
- J. IPC - ICC - International Plumbing Code

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Samples: Submit two lavatory supply fittings.
- D. Manufacturer's Instructions: Indicate installation methods and procedures.
- E. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- G. Maintenance Materials: Furnish the following for Owners use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Supply two sets of faucet washers.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for electric water cooler.

C. EXTRA MATERIALS

- 1. See Section 01 6000 - Project Requirements, for additional provisions.
- 2. Supply two sets of faucet washers, flush valve service kits, lavatory supply fittings, and toilet seats.
- 3. Supply two

PART 2 PRODUCTS

2.1 (LAV-#) LAVATORIES

A. Manufacturers:

- 1. Basin: (Vitreous China)
 - a. American Standard Inc: www.americanstandard.com.
 - b. Kohler Company: www.kohler.com.
 - c. Sloan Valve Company: www.sloanvalve.com.
 - d. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

2. Electronic Self-Generating Sensor Faucets:

- a. TOTO USA, Inc: www.totousa.com
- b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

3. Carriers:

- a. JOSAM Company: www.josam.com.
- b. J.R. Smith Company: www.jrsmith.com.
- c. Mifab Drainage Products
- d. Zurn Industries, Inc: www.zurn.com.
- e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

B. (LAV-1) LAVATORY, VITREOUS CHINA, WALL HUNG - Refer to Drawings for locations.

- 1. Vitreous China Wall Hung Basin: ASME A112.19.2; vitreous China wall hung lavatory, 20 by 18 inch minimum, with 4 inch high backsplash, rectangular basin with splash lip, front overflow, and soap depression. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
 - a. Drilling Centers: 4 inch.
 - b. Color: White
 - c. Basis of Design: Kohler; Kingston K-2005, 21-1/4" x 18-1/8", wall hung, drilled for concealed arm carrier system
 - d. Basis of Design: American Standard: Lucerne 0355.012, 20-1/2" x 18-1/4", wall hung, drilled for concealed arm carrier system
 - e. Basis of Design: Sloan SS-3003, 20-3/4" x 18-1/4", wall hung, drilled for concealed arm carrier system

2. Self-Generating Hydropower: chrome plated spout body, deck mounted with micro-sensor located underneath the spout head.
 - a. Water Supply: 3/8 inch compression connections.
 - b. Aerator: Vandal resistant, 0.5 GPM, laminar flow device.
 - c. Finish: Polished chrome.
 - d. Basis of Design: Toto Model: T28S51E
3. Accessories:
 - a. Mixing Valve: Below deck thermostatic tempering valve conforming to ASSE 1070 standard.
 - b. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
 - c. Chrome plated perforated grid strainer.
 - d. Commercial Grade, Loose key operated, 1/4 turn, chrome plated angle stops.
 - e. Flexible chrome plated copper supplies.
 - f. LavShield Drain and Supply shield, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84, ANSI A117.1/ADA compliant. Custom manufactured to fit underside of lavatory basin. Stainless steel fasteners. Truebro LavShield or equal.
4. Carrier:
 - a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.

2.2 (SINK-#) SINKS - REFER TO DRAWINGS FOR LOCATIONS.

- A. CONTRACTOR SHALL COORDINATE SPECIFIED SINK TYPE, SIZE, AND DIMENSIONAL REQUIREMENTS **WITH CASEWORK SUPPLIER IN FIELD PRIORTO RELEASE OF ORDER**. Contractor is responsible for final verification of size and type.
- B. Manufacturers:
1. Sink:
 - a. Elkay Corporation: www.elkayusa.com.
 - b. Just Manufacturing Co.: www.just.com..
 - c. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
 2. Supply Faucet:
 - a. Chicago Faucet, Inc Commercial Faucets:
 - b. Delta Faucet, Commercial Faucets:www.deltafaucets.com
 - c. Moen Commercial: www.moen.com
 - d. T&S Brass: www.tsbrass.com
 - e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.
- C. (SINK-1) - Single Compartment Bowl - ADA - Work Room.
1. Drop-in Sink: ASME A112.19.3, ANSI A117.1/ADA; 18 gage thick, Type 304 stainless steel, undercoated, with ledge back drilled for trim (3-hole punch).
 - a. Bowl Size: 14 in.(front to back) by 18 in. (side to side) by 5-1/2 in. deep
 - b. Overall dimension: 19-1/2 in.(front to back) by 22 in. (side to side) by 5-1/2 in. deep
 - c. Drain: 3-1/2 inch all metal crumb cup with strainer and 17 ga. tailpiece.(ADA units shall be provided with drain outlet centered-rear in bowl

d. Basis of Design:

1) Elkay; Model LRAD221955

2. Faucet: ASME A112.18.1; chrome plated brass supply with high rise 8" rigid gooseneck spout, vandal proof water economy aerator with maximum 1.5 gpm flow, 1/4 turn ceramic cartridge, 4-inch wrist blade indexed lever handles.

a. Basis of Design:

1) Moen Commercial; Model 8225SMF15

3. Accessories:

- a. Mixing Valve: Below deck thermostatic tempering valve conforming to ASSE 1070 standard.
- b. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
- c. Chrome plated perforated grid strainer.
- d. Commercial Grade, Loose key operated, 1/4 turn, chrome plated angle stops.
- e. Flexible chrome plated copper supplies.
- f. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84

D. (SINK-2) - Single Compartment Bowl - ADA - Kitchenette / Break

- 1. Sink: ASME A112.19.3; 22 in.(front to back) by 31 in. (side to side) by 5 in. (ADA) nominal outside dimensions 18 gage thick, Type 304 stainless steel, self rimming and undercoated, with ledge back drilled for trim (3-hole punch).
 - a. Drain: 3-1/2 inch all metal crumb cup with strainer and 17 ga. tailpiece.(ADA units shall be provided with drain outlet centered-rear in bowl.
 - b. Basis of Design:
 - 1) Elkay; Model LRADQ312250 (5" Deep, Center-Rear Drain)

2. Faucet: ASME A112.18.1; chrome plated metal construction, high arc swivel spout with pulldown spray, lever style handle w/duralast cartridge, 1.5 gpm.
 - a. Basis of Design:
 - 1) Chicago 434-ABCP
 - 2) Moen Commercial; Model Arbor 7594 (w/trim plate for 3 hole faucet punch)
3. Accessories:
 - a. Mixing Valve: Below deck thermostatic tempering valve conforming to ASSE 1070 standard.
 - b. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
 - c. Chrome plated tail piece with dishwasher connection
 - d. Chrome plated perforated grid strainer.
 - e. Commercial Grade, Loose key operated, 1/4 turn, chrome plated angle stops.
 - f. Flexible chrome plated copper supplies.
 - g. Drain and Supply Insulating covers, conforming to IAPMO standard PS94-2008 Section 3.5, ASTM E84

2.3 (WC-#) WATER CLOSETS

A. Manufacturers(All Water Closets)

1. Bowl:
 - a. American Standard Inc: www.americanstandard.com.
 - b. Kohler Company: www.kohler.com.
 - c. Sloan Valve Company: www.sloanvalve.com.
 - d. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

2. Flush Valves:

- a. TOTO USA, Inc: www.totousa.com
- b. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

3. Seats:

- a. American Standard: www.americanstandard.us.com
- b. Kohler Company: www.kohler.com.
- c. Bemis Manufacturing Company: www.bemismfg.com.
- d. Olsonite: www.olsonite.com.
- e. Kohler Company: www.kohler.com.
- f. Zurn industries, Inc: www.zurn.com.
- g. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

4. Carriers:

- a. JOSAM Company: www.josam.com.
- b. J.R. Smith Company: www.jrsmith.com.
- c. Mifab Drainage Products
- d. Zurn Industries, Inc: www.zurn.com.
- e. Other acceptable manufacturers offering equivalent products as approved by Architect/Owner prior to Bid. Refer to Division 01 specifications for additional information.

- B. (WC-1) WATER CLOSET, WALL HUNG (Student/Public Toilet Rooms) Refer to Drawings for locations.
1. Bowl: Vitreous China w/stain resistant antimicrobial finish, White, ASME A112.19.2, ANSI A117.1/ADA compliant, elongated rim, wall hung, siphon jet flush action, China bolt caps. Provide standard and ADA height units as designated on the Architectural Interior Elevation Plans.
 - a. Flush Volume: 1.1 - 1.6 gallon per flush
 - b. Supply Connection: 1-1/2 inch Top Spud
 - c. Outlet Size: 4 in.
 - d. Basis of Design:
 - 1) American Standard Inc; Model AFWall Millenium FloWise 3351.101 (wall hung, elongated, top spud)
 - 2) Kohler; Model Kingston Ultra K-84325-SS-0 (wall hung, elongated, top spud)
 2. Flush Valve (Ecco Power - Top Mount): ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
 - a. Self-Powered Hydroelectric: Self-cleaning piston with screen, Smart Sensor with self-adjusting detection range, True Mechanical Override push button, Metal Cover.
 - b. Exposed Type: All Chrome plated, sweat solder adapter with cover tube and cast wall flange, 1" screwdriver angle stop w/vandal resistant stop cap.
 - c. Flush Volume: 1.6 gpf
 - d. Basis of design:
 - 1) Toto Model: TET1GB32#CP
 3. Seats:
 - a. Solid white plastic, elongated, open front, extended back, stainless steel self-sustaining hinge, stainless steel or brass bolts, without cover and anti-microbial finish.

4. Water Closet Carriers:

- a. ASME A112.6.1M; adjustable compact cast iron frame, minimum 500 lbs. static load rating, integral drain hub and vent, metal nipple assembly, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers. Provide horizontal and vertical drain units as required by installation methods.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.
- C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall carriers and bolts.
- E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 9005, color to match fixture.
- F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

- G. Provide all transformers and low voltage wiring required for connection of plumbing fixtures. Install transformers and low voltage wiring in accordance with all manufacturers' requirements and recommendations. Line voltage power supply to the transformer shall be provided by the E.C.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. Clean plumbing fixtures and equipment.

3.7 SCHEDULES

- A. Fixture Heights: Install fixtures to heights above finished floor as scheduled below, where not indicated otherwise on Architectural Interior Elevations and Drawings.

1. Water Closet:

- a. Standard: 15 inches to top of bowl.
- b. Accessible: 18 inches (17 inches min. - 19 inches max.) to top of seat.
- c. Accessible (Children's Use - age 12 and younger): 15 inches (11 inches - 17 inches)

2. Water Closet Flush Valves:

- a. Standard: 11 inches min. above bowl rim. (coordinate installation at Accessible locations with manufacturers recommendations.)
- b. Accessible: 11 inches min. above bowl rim. max 44 inches above floor (field coordinate installation at Accessible locations with manufacturers recommendations and grab bar installation.)

3. Lavatory:
 - a. Standard: 31 inches - 34 inches to top of basin rim.
 - b. Accessible: 34 inches(max.) to top of basin rim.
- B. Fixture Rough-In Minimum rough in connection sizes indicated. Refer to plans for branch piping and DWV system connections)
 1. Lavatory:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 Inch.
 2. Sink:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 inch.
 3. Water Closet (Flush Valve Type):
 - a. Cold Water: 1 Inch.
 - b. Waste: 4 Inch.

END OF SECTION 22 4000

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SECTION 230501 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE:

- A. Provide a complete and operating HVAC system in accordance with these specifications and accompanying contract drawings. This shall include all required labor, materials, equipment, and supervision.
- B. Work shall include but is not limited to the following systems, equipment, materials, and labor for a complete system including the following:
 - 1. Packaged Rooftop Units (RTUs)
 - 2. Variable Frequency Drives (VFDs)
 - 3. Air Terminal Units (VAVs)
 - 4. Exhaust Fans
 - 5. Ductwork, Piping and associated Insulations
 - 5. Hydronic Specialties
 - 6. Automatic temperature control system.

1.2 PHASING:

- A. All work shall be undertaken to accomplish the work as indicated on the drawings and descriptions. Coordinate work with Owner to minimize shutdowns.

1.3 WORK RESPONSIBILITY:

- A. All structural supports required for the installation of equipment and materials shall be furnished by this contractor.
- B. All concrete work and pads for the installation of equipment and materials shall be furnished by this contractor.

1.4 DRAWINGS:

- A. Drawings are part of the bid documents and are intended to show approximate and relative locations of services and equipment. The drawings shall not be scaled to determine exact positions, locations, and clearances.
- B. Due to the diagrammatic layout and small scale of the drawings, certain piping and duct rises, drops, offsets, valves, and related specialties are not shown. The contractor shall provide all ductwork, piping, fittings, valves, and specialties required to insure a complete installation without additional cost to the owner.

- C. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical, and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to consult other trades, this Contractor shall rearrange his work at his own expense.

1.5 FIRE UNDERWRITER SEAL:

- A. Where applicable, all material shall bear the National Board of Fire Underwriters' Seal of Approval. Certificates to this effect shall be furnished to Architect upon request.

1.6 CONCRETE AND MASONRY WORK:

- A. The Contractor shall furnish and install all concrete bases, reinforcing, etc. required to install the Mechanical Work, unless otherwise noted.
- B. The Contractor, prior to installing any forms, reinforcing or concrete, shall notify all other Contractors or subcontractors, in ample time for them to install any portion of their work which is to be concealed in the concrete. No such work shall be placed in a manner to interfere with the proper placing of the reinforcement unless so authorized by the Architect.

1.7 ANCHOR BOLTS:

- A. Each Contractor shall provide and set in place at the time the foundations, bases, or curbs are poured, all necessary anchor bolts as required for the various equipment specified herein, to be furnished by him under these Specifications. Anchor bolts must be of the hook type and of the proper sizes and length to suit the apparatus. The bolts shall be set in pipe sleeves of approximately twice the bolt diameter and as long as the imbedded length of the bolt.
- B. When the equipment is set in its proper position, the bolt sleeves and the space between the rough foundations, bases or curbs of the equipment shall be completely filled with one inch of non- shrinking cement grout.
- C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by him under these Specifications, and must have a man present at the time the foundation, bases, or curbs are poured.

1.8 SLEEVES:

- A. Each Contractor shall furnish and set all sleeves required for the installation of his work and shall be responsible for their final and permanent locations.
- B. All pipes passing through masonry construction shall be fitted with sleeves. Each sleeve shall extend through its respective floor or wall and shall finish flush with each surface unless otherwise required. Unless otherwise specified or shown, sleeves shall be one

pipe size larger than the overall outside diameter of the pipe when insulated. Sleeves in bearing and masonry walls shall be made of standard weight steel pipe.

- C. Sleeves for pipes passing through non-fire rated floors: 18 gage galvanized steel.
- D. Sleeves for pipes passing through non-fire rated beams, walls, footings, and potentially wet floors: Steel pipe or 18 gage galvanized steel.
- E. Sleeves for rectangular ductwork: Galvanized steel and framing as shown on details.
- F. Firestopping for non-plastic piping, ductwork shall be 3M, Dow, Corning fire caulk/packing or accepted equivalent. Install steel angles around duct penetrations. Refer to Division 7. All fire stopping furnished by all contractors on the project shall have the same manufacturer.
- G. All sleeves shall be properly installed and securely cemented in place. Where pipes pass through waterproofed floor or walls, design of sleeves shall be such that the waterproofing can be properly flashed around the sleeves, and of such height that the water will be restrained from entering sleeves and dripping to any finished areas below.
- H. Where pipes pass through fire resisting portions of the structure, the annular space between the sleeve and the pipe shall be filled with an approved fireproof material.

1.9 ESCUTCHEONS:

- A. All exposed pipes, except as otherwise described, passing through walls, floors, ceilings, etc. in finished spaces, shall be provided with solid pattern heavy ceiling, floor or wall escutcheons with set screw. Escutcheons and plates shall be of steel or malleable iron with prime coat ready for painting. Escutcheons will not be provided where sleeves intentionally extend above finished floor.

1.10 CUTTING AND PATCHING:

- A. All cutting and patching of every nature required in connection with these Contracts shall be done by each Contractor with mechanics experience in their respective lines of work. All patching shall match adjacent finishes.
- B. All cutting in the building shall be done with great care so as not to leave an unsightly surface which may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through the fault of the Contractor, he shall be required at his own expense, to engage a Contractor to replace the damaged materials with new materials.
- C. Cutting and patching of the existing building shall be done by this Contractor. All holes cut shall be in a manner approved by the Architect and all patching shall be done so as to match the existing construction and finish. The Contractor shall patch all openings left

in present walls, floors and ceilings when ductwork, piping and other materials are removed.

- D. Where it becomes necessary to cut out any portions of walls, floors, ceilings, roof or other portions of the building for the installation of work as may be required to perform and complete the work under this Contract, the Contractor shall do all necessary cutting and fitting, shall remove all excess material, and shall replace all work damaged so as to leave the entire premises in a finished condition.
- E. No cutting shall be done which may in any way affect the building structurally or architecturally. Any damage incident to cutting or other causes in the performance of this Contract shall be made good by replacement or repairs to the Owner's satisfaction. Cutting shall be done only with the prior approval of the Architect.

1.11 GUARANTEE:

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one year from date of substantial completion. The Contractor shall provide free service including parts replacement for all equipment involved in his Contract during this guarantee period.
- B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.
- D. Refrigeration compressors shall have a five-year guarantee including refrigerant and refrigerant systems.
- E. All work done under these contracts shall be guaranteed by the respective contractors against defective materials and faulty workmanship for a period of 1 years from the date of substantial completion.
- F. During such a period, and before the expiration of each such guarantee, contractor shall agree to make any and all repairs, adjustments, or replacements which may become necessary, owing to initial settlement or shrinkage, defective material, workmanship, or installation.
- G. He shall further agree to provide all labor and material which may be required and to restore to its original condition any adjacent work that he may disturb in making the necessary repairs, adjustments, or replacements in order to fulfill this guarantee.

1.12 CLEANING OF SYSTEMS:

- A. The Contractors shall thoroughly clean all pipe and ductwork systems to remove all grease, oil scale, core, sand and other foreign material after tests have been made and before the building is turned over to the Owner.
- B. All strainers shall be opened and cleaned thoroughly.
- C. Should the Contractor put any substance into any system to aid in the cleaning of it, all trace of such material shall be removed before the system is considered clean. All such substances, if used, shall be free from any acid that will set or injure valve seats in any way.

1.13 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him.
- B. Three copies of factory installation and maintenance schedules shall be furnished for each piece of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.
- C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory working condition.

1.14 SUBSTITUTIONS:

- A. Various items of equipment and materials that have been used as the basis for mechanical system design have been specified by a manufacturer's name and model number. Another manufacturer's product may be submitted or has been specified for consideration as a substitute. The Architect/Engineer shall be the sole judge as to the comparability of an item of equipment that is submitted for approval as a substitute for that which is specified. Each of the Contractor's substitute proposals shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports, fittings, ductwork, motors, controls, electrical wiring, and thermal insulation. It shall be the responsibility of the Contractor to make certain that substitute equipment, which has been accepted by the Architect/Engineer will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing. All equipment other than the basis of design shall be considered a substitution.

1.15 ALTERNATES:

- A. Various items of equipment and materials that have been used as a basis for mechanical system design have been specified by a manufacturer's name and model number. Where another manufacturer's product has been specified as an alternate to this equipment the proposed cost for this alternate shall include all labor and materials that will be required to install the equipment and make it operate satisfactorily in accordance with the original design concept. He shall include such things as changes in piping, valves, supports and supporting structure, fittings, ductwork, motors, controls, electrical wiring and thermal insulation. It shall be the responsibility of the contractor to make certain the alternate equipment will fit into the designated spaces. He shall make the necessary field measurements in order to determine that there is adequate space for the equipment, taking into consideration the clearances that are required for connections and servicing.

1.16 ALIGNMENT:

- A. Where several receptacles, devices, bells, alarms, thermostats, switches, handles, etc., are to be installed in a common location, this equipment shall be lined up in a vertical plane. It is the Contractor's responsibility to confer with the Architect on this alignment.
- B. The Mechanical and Electrical Contractors shall carefully check all the Drawings and coordinate their work with all trades to provide for a symmetrical and coordinated ceiling. Ceiling T-bars, lights, registers, and other equipment shall all be symmetrically installed with provisions made for integrating the T-bars and this equipment. Failure to coordinate will result in relocation of ceiling components as directed by the Architect at the Contractor's expense.

1.17 OPERATION AND MAINTENANCE INSTRUCTIONS:

- A. Upon the completion of this project, the Contractor shall deliver to the Architect/Engineer for approval, one hard copy and one electronic copy of operating and maintenance manual consisting of the items outlined hereinafter.
- B. The purpose of this manual is to assist the Owner in routine operation, maintenance, servicing, troubleshooting and procurement of replacement parts. All information in the manual shall be as-built and only material pertinent to the project shall be included.
- C. The operating manual shall be considered a part of the final inspection and shall be submitted for review and approval at least 30 days in advance of a request for final inspection. The manual shall include:
 - 1. A copy of all final corrected equipment submittals, control diagrams, descriptive brochures, and a list of all parts of each piece of mechanical and electrical equipment which has been furnished and installed.
- D. Complete and detailed typewritten operating and maintenance instructions for all major operating equipment. The operating and start-up instructions shall be written in a

concise, step by step manner. Maintenance instructions shall include such things as periodic checks, adjustments and trouble- shooting techniques. Specifications for lubricants and other required fluids shall be included.

- E. A listing of all items of mechanical and electrical equipment, a compilation of the nameplate data for this same equipment, the name, address and telephone number of the nearest service organization.
 - 1. Copies of all A.S.M.E. pressure vessel certifications, state approved tank permits, complete additional valve tag schedules, all electrical inspection permits and all additional mechanical and electrical permits required for occupancy by the Owner.
 - 2. All of the materials shall be indexed by specification section, arranged categorically and be bound in a rigid, plastic covered, three ring binder.

1.18 PAINTING:

- A. Provide corrosion inhibiting prime coating on all ferrous materials. Comply with Division 9 of the specifications

1.19 RULES AND REGULATIONS

- A. All work shall be performed in accordance with the rules and regulations of Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration), the Department of Education, the Department of Environmental Protection, and all codes and agencies having jurisdiction.
- B. All construction, design fabrication, tests, rating and installation shall comply with the rules and regulations of all local, state or national codes and agencies having jurisdiction over this project. Any costs involved in complying to these rules and regulations shall be included in original bid of this Contractor.
- C. The Owner will obtain the building permit. Any other fees relative to the contractor's work shall be paid by the contractor as part of his Bid.

1.20 SUBMISSION OF SHOP DRAWINGS, EQUIPMENT, AND MATERIALS

- A. The Contractor shall submit, with a letter of transmittal to the Architect, 6 sets of shop drawings containing all capacities, performances, features, options, accessories and technical data of all materials and equipment listed herein. All submittals shall be made within 45 days after awarding of the contract.
- B. Refer to Division 1.
- C. All disapproved submittals shall be corrected as directed by the Architect and resubmitted in 6 sets until approved within 30 days after the original submittal was disapproved. No work involving any materials or equipment covered by shop drawings shall be started until the respective shop drawings are approved.

- D. Submit electric copies of all submittals to the Architect/Engineer.
- E. No equipment or materials shall be installed until final approval has been given by the Architect/Engineer.
- F. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number and specification section number, as appropriate on shop drawings.
- G. On shop drawings, apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the Work and Contractor Documents.
- H. On shop drawings, provide space for Contractor and Architect/Engineer review stamps.
- I. Contractors shall include with each submittal/shop drawing, a matrix outlining all items that do not match the specified unit. If an item is not listed on the matrix, the submitted unit will be assumed to meet all parts of the specification. Contractors will be responsible to ensure that the specifications are met in full. Items in matrix shall include schedule performance data vs submitted performance data, specified components vs submitted unit components, specified construction weight, warranty, etc. vs submitted construction, weight, warranty, etc.

1.21 VISITS TO THE SITE

- A. Prior to submission of his bid, the Contractor shall visit the site to acquaint himself with the existing conditions. Bids as submitted will be interpreted to include all cost and change made necessary by such conditions.

1.22 COORDINATION OF WORK

- A. Contractor shall coordinate his work with the of other trades. In case of interference or problems the Architect shall decide which work is to be relocated, regardless of which is installed first.

1.23 LOCATION OF EQUIPMENT

- A. All locations of plumbing, HVAC and fire protection equipment and pipe connections there to shall be verified by the Engineer and Architect. The contractor shall verify locations sufficiently in advance of the installation to allow uninterrupted progress of the work of all trades.
- B. The Mechanical Contractor shall prepare dimensioned coordination/arrangement drawings at a scale of (1/4" = 1'0"). Layouts represented by these drawings shall be coordinated with all other trades. Refer to Division 1 requirements for project coordination.

- C. This Contractor shall obtain Architect approval of all arrangement drawings before continuing his work.

1.24 MATERIALS AND EQUIPMENT

- A. All materials and equipment, unless otherwise specified, shall be new and of the best quality, approved for their specific application.
- B. This Contractor shall provide, when required by the Architect, labeled samples of materials to be used on this project. Samples shall be submitted for approval to the Architect prior to their installation.
- C. All materials and equipment installed by the Contractor shall be securely and rigidly supported from or attached to the building structure.

1.25 WORKMANSHIP

- A. All workmanship shall be done according to the best practices of the trade by qualified and competent tradesmen.

1.26 PROTECTION OF EQUIPMENT

- A. The Contractor shall protect all material and equipment from damage until final acceptance as installed. He shall close all openings during construction with temporary plugs and replace all damaged items with ones of exact sameness at his expense.
- B. He shall schedule material and systems for delivery in such a pattern that critical pieces of equipment may be stored within the building, protected from weather. Where materials are stored outside, they must be protected from the elements and damage.
- C. This Contractor shall be responsible for coordinating the procurement of specified materials and equipment being supplied by his sub-contractors and suppliers.

1.27 SCAFFOLDING AND HOISTING

- A. The Contractor shall furnish and erect all scaffolding, hoists, shoring, platforms, railings, ladders, and other devices required by local, state, and federal laws to install his systems and equipment. Scaffolding and all other equipment shall be removed at completion of the work.
- B. Contractor shall hoist or rig his own material and equipment into place, or arrange for the rigging of it by others at his expense.

1.28 FOREMAN

- A. Each contractor must provide a competent foreman, subject to approval of the Architect/Engineer. The foreman shall be deemed the agent of the Contractor and must be on duty at the building during all working hours. If work is occurring in more than one shift, provide a foreman for each shift.
- B. Any instructions or notices given to the foreman shall have the same force as if given to the Contractor in person.

1.29 PAINTING

- A. All exposed piping, iron work, and equipment installed in the mechanical equipment rooms under this contract shall be painted 1 prime coat and 2 coats of best quality oil paint of color as selected by the Architect.

1.30 CLEANING

- A. Upon completion of the installation, thoroughly purge all piping of all piping of all obstruction and scale and adequately flush all liquid carrying piping to assure a clean system. Flush and treat all systems in each phase as required to meet phasing requirements. See Section 23 2500.
- B. Wash all fixtures with soap and water, remove labels and protective covering and clean all grease and cutting from plates or polished piping and trim.
- C. Where damage to finish, furnishing or parts of the building results from pipe stoppage or from failure to clear and flush piping systems properly, the Contractor shall at his own expense, employ qualified skilled labor to make repairs.

1.31 CLEANING AND FINISHING

- A. After all tests have been made and the system proven satisfactory to the Architect, the Contractor shall go over the entire project, clean all equipment and material installed by him, and leave in a clean and working condition.

1.32 INSTRUCTION OF EMPLOYEES

- A. At the completion of the work this Contractor shall instruct the employees who shall have charge of the equipment in the care, adjustment, and operational of all parts of the system.
- B. At the time designated by the Architect, the equipment manufacturer's engineer shall instruct representatives of the Owner in the operation and maintenance of the equipment.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment to permit removal of components and parts which require periodic replacement or maintenance. Arrange pipes, ducts, and equipment to permit access to valves, gauges, starters, motors, doors and access panels.
- B. Provide access panels in equipment, ducts, etc. as required for inspection and maintenance.

3.2 PIPING INSTALLATION

- A. In general, piping shall be exposed in equipment rooms, and concealed in all finished rooms. Where piping is exposed, it shall be run so as to allow maximum headroom consistent with proper pitch. No piping or ductwork shall cross below the head of any window or door.
- B. Exposed piping, ducts, conduits, and/or appurtenances indicated on the inside of buildings, shall be installed parallel to the building lines. All piping shall be kept as close as possible to the ceilings, walls, and columns, to take up the minimum amount of space.
- C. All work shall be arranged and installed as high as possible to prevent obstruction of window areas, and to give adequate clearance and access for operation and maintenance.

3.3 SLEEVES

- A. Where pipes pass through concrete or masonry walls or concrete floors, they shall be protected through the full depth of the construction with galvanized sleeves; same to be at least one size larger than the pipe plus insulation.
- B. Where sleeves occur in concrete floors, the top of sleeve shall be 2" above the finished floor line, and the end shall be filed to a smooth round finish.
- C. This Contractor shall supply all pipe sleeves and shall inform sub-contractor of exact sleeve locations in time for their incorporation onto the concrete forms or masonry work.
- D. The space between pipes and sleeves shall be caulked air tight with a non-combustible inorganic material.

3.4 UNIONS

- A. Unions shall be provided at all connections to each piece of equipment and on both sides of all automatic valves, and devices which requires removal for maintenance. No unions are to be placed in a location which will be inaccessible after the completion of the project.
- B. Unions of copper tubing shall be 200 lbs. SWP brass ground joint.
- C. Unions for steel pipe shall be 250 lbs. SWP, malleable iron with brass to iron seat.

3.5 CLEARANCE

- A. All piping, including valves and fittings shall be installed to provide the following minimum clearances between the finish coverings, adjacent pipe and/or conduits: 4" between for piping services and 6" between piping services and electrical conduits.

3.6 ESCUTCHEON PLATES

- A. All piping passing through walls, ceilings, and floors shall be provided with escutcheon plates securely fastened in place. Where installed on piping in finished areas they shall be chrome plated.

3.7 APPLICATIONS OF INSULATION AND COVERING

- A. No covering shall be installed by the Contractor until the piping and ducts have been approved by the Architect/Engineer/Construction/Owner.

3.8 INSERTS

- A. Except as noted, provide box type inserts for all hangers and supports intended to suspend piping or light weight equipment from new concrete construction. Fasten all inserts of the form work before concrete is poured. Inserts to be Grinnell Figure No. 282 or Figure No. 279 depending upon the maximum load to be carried.
- B. No toggle bolts, expansion screw anchors or similar imbedded hanger supports shall be used in new construction.

3.9 CHASES AND OPENINGS IN FLOORS AND WALLS

- A. It shall be the duty of the Contractor requiring chases, openings or the placement of any sleeves, anchors, and supports required for his work, whether or not shown in the drawings, to advise the subcontractor accordingly (if necessary). He shall furnish all such sleeves, anchors, and supports in place, and all necessary information for the proper location of said chases or openings. Show all information on the coordination drawings.
- B. If a contractor shall fail to observe and comply with those requirements, he shall cut, at his own expense, after receiving the consent of the Architect/Engineer, such chases or opening as may be necessary and proper, providing and building in place all lintels required by these openings, doing the necessary patching and rebuilding of the work required and he shall be responsible for all loss or delay resulting therefrom.

3.10 EQUIPMENT BASES AND SUPPORTS:

- A. Provide housekeeping pads of concrete, minimum 4" thick and extending 4" beyond supported equipment.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten and flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.11 AS-BUILT DRAWINGS:

- A. During construction, the Contractor shall maintain a record set of installation prints. He shall record on these prints, all deviations from the Contract Drawings in pipe sizing, location, and details. The record set of installation prints shall be updated at the end of each month and shall be delivered to the the Architect.
- B. At the completion of the work, the Contractor shall forward these prints to the Architect for incorporation into the final As-Built Drawings. The document shall be hard copies and electronic copies.

END OF SECTION 230501

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 RELATED SECTIONS

- A. Section 23 0514 - Variable Frequency Drives.

1.3 REFERENCES

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; 1990 (Reapproved 2000).
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; Institute of Electrical and Electronic Engineers; 2004.
- C. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.
- D. ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers) Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.

- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.5 QUALITY ASSURANCE

- A. Conform to NFPA 70.
- B. Motors shall comply with ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings current edition.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Century
- B. Baldor
- C. Lincoln Motors
- D. A. O. Smith Electrical Products Company

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Construction:
 - 1. TEFC type except where specifically noted otherwise.
 - 2. Design for continuous operation in 40 degrees C environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 4. All motors shall be high efficiency type.

- B. Provide motors with phase loss protection.
- C. Motors for use with VFD's shall be designed and approved by the manufacturer for use with VFD's.
- D. Mechanical Contractor shall provide all motors that are required. Each motor shall be the correct service type and have a horsepower rating that is adequate for the device it is intended to drive. Motors shall not exceed their full load rating, including the service factor rating, whenever the driven equipment is operating at the specified capacity under normal operating conditions.
- E. Insulation shall be Class B. Motors shall be drip-proof in dry, non-hazardous locations, weather protected where exposed to the weather or dampness, and totally enclosed, fan cooled where specified. Drip-proof and totally enclosed fan cooled motors, fractional and integral horsepower, shall have service factor ratings of 1.15 and 1.0 respectively. Fractional horsepower motors shall have sealed, permanently lubricated, ball bearings unless sleeve bearings are standard with a manufacture of equipment which utilized direct driven fans. Integral horsepower motors shall have ball bearings with grease zerk fittings and drain ports. All motors shall be rated for continuous duty. Maximum temperature rise shall not exceed 40 degrees C. for drip-proof frame motors and 55 degrees C. for totally enclosed motors in a 40 degrees C. ambient condition. Motors shall be suitable for the electrical service specified, scheduled or shown.
- F. Motors shall have been tested and approved by the Underwriters' Laboratories, Inc. Motors shall be manufactured and classified in accordance with the current NEMA Standard Publication No. Mg 1 entitled "Motors and Generators."
- G. Motors shall be dynamically balanced and tested at the factory before shipment. They shall be relatively quiet while running. Connections to direct driven devices shall be made with a flexible coupling. Motors for V-belt drive service shall be furnished with a steel base and a screw device for adjusting belt tension.
- H. Motors shall be mounted so that they are readily accessible for maintenance. Motor terminal boxes shall be accessible. Covers shall not be blocked by other equipment. Watertight terminal boxes shall be provided on those motors in wet locations or where they are exposed to the weather. Motor mounting arrangement shall be such that the motor mounting bolts are accessible in order to facilitate its removal.
- I. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.
- J. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

K. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.3 ELECTRICAL CONNECTIONS

- A. All electrical connections shall be made by the Electrical Contractor. Motors and controls for equipment furnished by each Contractor shall be furnished and set by the Contractor furnishing the equipment. Where electrical work is specifically indicated to be performed by the Plumbing, Fire Protection or Heating Contractor, this Contractor shall perform the work in conformance with Electrical Specifications for this project.

2.4 MOTOR CONTROLLERS

- A. Mechanical Contractor shall provide motor controllers. The items shall be products of one manufacturer, Allen-Bradley, Square D, General Electric or Westinghouse, and shall meet latest N.E.M.A. and IEEE Specifications. Starters and contactors shall be horsepower rated. Starters shall include the proper size heater elements
- B. Magnetic starters shall be provided with "On-Off-Auto" switches on the starter.
- C. Unless otherwise noted, control and pilot devices such as electric thermostats, alternators, float controls, aquastats, etc., shall be furnished and installed by the Mechanical Contractor. Each device shall be provided with all auxiliary features and accessories which may be required for correct operation of the associated equipment.
- D. Magnetic starters shall be provided with start-stop-HOA push buttons on the starters unless remote control pushbuttons or other methods of starting are specified elsewhere.
- E. Unless otherwise noted elsewhere, all magnetic motor starters controlled with a remote pilot device shall contain a control circuit transformer, as an integral part of the controller, providing control power at a maximum 120 volts for the pilot device. The exact control circuit voltage shall be coordinated with the ATC supplier prior to the purchase of any motor controllers.
- F. Starters and protective devices which are provided as an integral part of the equipment furnished under the Mechanical Contract, shall be supplied.

- G. For use in manual starting of fractional horsepower motors up to but not including 1/2 horsepower, the Mechanical Contractor shall furnish a thermal manual toggle switch type starter with pilot light specifically designed for this purpose. Each starter shall be provided with proper size heater element for the motor to be controlled. Heater elements shall be readily removable and interchangeable. Starters shall be arranged for flush or surface mounting as indicated or as required.
- H. Controllers and wiring diagrams shall be delivered to the Electrical Contractor.

2.5 MOTOR DISCONNECTS:

- A. Unless otherwise noted, motors located out of sight of their respective electric panels shall be provided with disconnect switches at the motors by the Electrical Contractor.
- B. All exhaust and supply fans on the roof shall be provided with disconnecting means at the motors as an integral part of the equipment.

2.6 ENCLOSURES:

- A. Motor controllers and disconnects shall be provided with standard approved enclosures to suit the locations in which they are installed and the conditions under which they are to operate.

2.7 MOTOR CONTROL WIRING:

- A. The Electrical Contractor shall run the power wiring system from the various supply panels indicated, to the motors and motor controllers and shall make final connections unless otherwise noted on the Drawings. The Mechanical Contractors shall run all control wiring from the motor controllers to the pilot devices.
- B. Starters, and protective control devices which are provided as integral part of the motors or motor-operated equipment shall be prewired at the factory.
- C. After final connections are completed, the Mechanical Contractor shall test each motor for proper rotation. Before applying current to the motor, the Mechanical Contractor shall check the motor for alignment, oil, etc. The Mechanical Contractor shall make any necessary adjustments to the starter and control equipment for proper starting and overload protection.

END OF SECTION 230513

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SECTION 230514 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of the Contract, including General and Supplementary Conditions apply to the Work of this Section.
- B. Section 23 0993 - HVAC Control Sequence.
- C. Section 23 0923 – Direct Digital Control System

1.2 DESCRIPTION OF WORK:

- A. Extent of work is hereby defined as the furnishing and installation of variable frequency drives of the types and sizes as indicated on the Drawings and as specified herein.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Subject to compliance with the requirements of this section, provide variable frequency drives as manufactured by Square D, Danfoss, or ABB. ABB is the District's preferred vendor.
- B. NFPA Compliance: Comply with applicable provisions of ANSI/NFPA 70 "National Electric Code", pertaining to the construction and installation of electrically operated components.
- C. NEMA Compliance: Comply with applicable provisions of NEMA Standards pertaining to motor starters, control panels, and wiring devices.
- D. UL Compliance: Provide electrical components which have been tested, approved, and labeled by Underwriters Laboratories.

1.4 SUBMITTALS:

- A. Division 1 contains definitions, requirements and procedures for the following submittals:
 - 1. Shop Drawings
 - 2. Guarantees
 - 3. Product Data

1.5 WARRANTY:

- A. Division 1 - Closeout Submittals, for additional warranty requirements.

PART 2 - PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES:

- A. General: Provide variable frequency drives (VFD) for equipment as scheduled and as shown on the drawings to vary the speed of the three phase AC motors to proportionately control the air or water flow of each system. The VFD shall utilize a 16-bit microprocessor for sine-coded pulse width modulation of AC induction or synchronous motors.
- B. Input Power: The VFD shall accept required input voltage within a $\pm 10\%$ variation.
- C. Output Power: The VFD output power shall vary frequency to the motor from 0 to 400 Hz with resultant motor speed varying at the motor nameplate rated speed, with output voltage variation from zero to motor rated voltage for optimum volts per hertz (V/Hz) ratio for fan loads. Output currents shall be rated 125% of motor full load amps for 1 minute based upon VFD's variable torque rating. The output shall be a voltage source type generating a sine coded PWM waveform utilizing an asynchronous carrier frequency up to 15000 Hz. The carrier frequency shall be adjustable to minimize harmonically induced noise or vibration.
- D. Power Structure: The VFD power input stage shall convert three phase AC line power to a fixed DC bus voltage by using a full wave diode rectifier with three phase protection. Power factor shall be .98 or corrected with capacitors. The VFD shall have power component monitoring/protection, short circuit power protection, and capacitive filtering of DC power. Switching transistors shall convert DC power to sine coded pulse width modulation voltage for motor control. Current transformers shall monitor output current and be used by the microprocessor for: thermal overload protection, three phase current limit, ground fault and short circuit protection, and motor restart with speed search. Insulated Gate Bipolar Transistors shall be utilized for a fixed carrier frequency of 15,000 Hz.
- E. Operation and Protective Functions: The VFD shall be capable of performing the following operational functions in addition to providing built-in protective features:
 - 1. DC injection braking with adjustable start frequency, current limit and time duration to provide braking before fan start-up.
 - 2. Programmable critical frequency interruptive to lock-out up to 3 frequency ranges, 0 to 10 Hz, to avoid motor operation at resonant speeds.
 - 3. Speed search to restart motor while fan is still rotating.
 - 4. Reference speed loss detection to continue fan operation if the reference frequency is interrupted. Motor shall be operated at 80% of last reference valve.
 - 5. Programmable auto restart and stall prevention to adjust output frequency to avoid overload or overcurrent conditions.
 - 6. Power-loss ride through to automatically restart the motor after a power interruption less than two seconds duration.
 - 7. Reverse rotation prevention.

F. Control Terminal Functions: A control terminal strip shall be provided to accept the following external control commands:

1. Forward Run/Stop to initiate or stop VFD operation.
2. Speed Reference Input to accept an instrument follower signal of either a) 0 to 10 VDC, b) 4 to 20mA, or c) 1 to 5 VDC as determined by the Automatic Temperature Control Contractor.

G. Multi-function output contacts programmable for any of the following indications:

1. Run mode
2. Zero speed detect
3. Over-torque detect
4. Coast to stop detect
5. Run reference mode
6. Speed reference mode
7. Speed synchronization
8. Output frequency detect
9. Low voltage detect
10. Operation ready
11. Speed reference loss detect
12. Braking resistor fault
13. Drive fault
14. Output fault relay contact to indicate AFD diagnostic fault detection.
15. Terminal for HOA switching.
16. Input terminal to shut down motor operation on smoke detection signal or other external fault signals.
17. Analog output signal, 0 to 10 VDC, proportional to output frequency or output covered.

H. Local Operator Control: The VFD shall have a front mounted sealed touch-pad operator to include:

1. Local run/stop keys
2. Local speed command
3. Reset push button
4. Digital output frequency meter and speed reference meter which both can be reprogrammed for other speed related indications, including RPM, CFM, FPM, etc.
5. Digital voltmeter.
6. Digital kilowattmeter.
7. Digital ammeter.
8. Input and output terminal status indication.
9. Ability to program various control functions without necessity of stopping drive while in Run mode, including but not limited to the following:
 - a. Acceleration and deceleration
 - b. Frequency command bias and gain
 - c. Torque compensation
 - d. Slip compensation

- e. Energy savings gain
- f. Multi-step speed references
- g. Digital diagnostic indication and protection for:
 - 1) DC bus undervoltage
 - 2) DC bus over voltage
 - 3) Load over torque
 - 4) Fuse blown
 - 5) Motor overload
 - 6) AFD overload
 - 7) Heatsink over temperature
 - 8) Instantaneous over current
 - 9) Operator error
 - 10) Central processor fault
 - 11) External fault
 - 12) Dynamic braking fault
- I. VFD Adjustments: The microprocessor control AFD logic shall include the following adjustments:
 - 1. Maximum output frequency - 0 to 400 Hz.
 - 2. Minimum output frequency - 0 to 400 Hz.
 - 3. Acceleration time -.1 to 6000 seconds.
 - 4. Deceleration time -.1 to 6000 seconds.
 - 5. Current limit - 0 to 170%.
 - 6. 15V/Hz pre-set selection patterns.
 - 7. Capability to program a totally customized V/Hz pattern.
 - 8. Auto speed reference (instrument follower) input adjustable for bias and gain.
 - 9. Stall prevention accomplished by reducing output voltage and frequency during momentary overload. When overload clears, drive will automatically resume normal operation.
 - 10. Adjustable torque and/or current limit.
 - 11. Ramp to stop or coast to stop selection.
 - 12. Capability to set upper and lower frequency limits independent of min and max V/Hz frequency patterns.
 - 13. Linear or S-curve function for soft start.
 - 14. Two independent, selectable accel/decel ramp functions.
 - 15. A minimum of 4 programmable multi-function inputs.
 - 16. External start/stop shall be programmable for either 2 wire or 3 wire control. 3 wire option should not require a holding contact.
 - 17. There shall be a programmable lock out code available to prevent operator access to parameter setting.
 - 18. A selectable/adjustable energy saving gain shall be available that can be activated during frequency command synchronization.
 - 19. Minimum of 9 preset speeds.
 - 20. Up/down frequency setting.
- J. Electronic Bypass: The VFD shall have a bypass to allow operating the connected motor in the event of VFD failure.

- K. Systems Integration: VFD manufacturer shall provide BACNET IP network card to interface with BAS system.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install all equipment listed in this section in accordance with the manufacturer's written instructions and wiring diagrams or as directed by factory service personnel.

3.2 START-UP:

- A. Do not place VFD's into start-up until mechanical and electrical systems are fully operational including installation of terminal equipment and automatic temperature controls.
- B. The VFD manufacturer's factory trained service personnel shall perform all programming and start-up procedures.
- C. Instruct Owner on operation of unit. Provide minimum 4 hours instruction.

3.3 TESTING AND ADJUSTING:

- A. The manufacturer's factory trained service personnel shall test each unit through the full range of operation including checking all input/output signals, and fault conditions.
- B. Manufacturer shall validate system is fully functional and operation perfectly upon completion of testing and adjusting.

3.4 SCHEDULE:

- A. Pumps:
 - 1. Provide variable frequency drives for all dual temperature, chilled water and hot water pumps.

END OF SECTION 230514

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SECTION 230515 - REMOVALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division I Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

- A. This Contractor shall be responsible for the removal of existing piping, fixtures, ductwork, equipment, insulation, and controls in the existing building which is shown on the Drawings or which is in conflict with the new construction or new mechanical systems. Existing piping, equipment and ductwork which are removed shall be disconnected at their source and capped. Furnish all labor, equipment hauling, rigging, scaffolding, etc. necessary for the removal phase of the project.

1.3 GENERAL:

- A. Existing piping, fixtures, equipment, ductwork and related accessories which require systems to be shut-down shall be coordinated with the Owner. Periods of shut-down shall be minimal and all new work shall be planned and scheduled to accomplish as few shut-downs as possible.
- B. All construction and removal work shall be performed in a manner as to keep the existing systems in operation as the work progresses. Prior to commencing construction, the contractor shall review the construction schedule with the Owner and Architect to assure a well-coordinated schedule.
- C. Cutting and patching in concealed and exposed locations shall be by this Contractor unless specifically noted otherwise.
- D. The Owner shall have the option of keeping any or all salvageable items removed from building such as motors, control components, refrigerant etc. Any items removed from the building that Owner does not wish to keep shall become the property of this Contractor and he shall dispose of these items.

END OF SECTION 230515

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SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pressure gages and pressure gage taps.
- B. Thermometers and thermometer wells.

1.2 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.

1.3 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; The American Society of Mechanical Engineers; 2013.
- B. ASTM E1 - Standard Specification for ASTM Thermometers; 2013.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2007.
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Shop drawings: Provide manufacturer's cut sheets for all devices.
- C. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 - Product Requirements. for additional provisions.

1.5 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:

1. Dwyer Instruments, Inc.
2. Moeller Instrument Co., Inc.
3. Omega Engineering, Inc.
4. Weksler

B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background. All gauges to be liquid filled type.

1. Case: Steel with brass bourdon tube.
2. Size: 4-1/2 inch diameter.
3. Mid-Scale Accuracy: One percent.
4. Scale: Psi.

2.2 PRESSURE GAGE TAPPINGS

A. Gage Cock: brass for maximum 150 psi. Provide brass needle valve with brass gauge snubber.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc: www.dwyer-inst.com.
2. Omega Engineering, Inc: www.omega.com.
3. Weksler Glass Thermometer Corp: www.wekslerglass.com.

B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

1. Size: 9 inch scale.
2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
- C. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Provide instruments with scale ranges selected according to service with largest appropriate scale.
 - 1. 20 F to 80 F for chilled water only thermometers.
 - 2. 40 F to 240 F for hot water/dual temperature thermometers.
- F. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- G. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

END OF SECTION 230519

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SECTION 230549 - VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SUMMARY:

- A. The extent of vibration isolation work is indicated by Drawings and schedules and by requirements of this Section.
- B. The types of vibration isolation specified in this Section include the following:
 - 1. Support isolation for motor driven Mechanical Equipment.
 - 2. Support isolation for piping and piping risers.
 - 3. Flexible connections for piping at Equipment.
 - 4. Flexible ductwork connections.

1.2 SUBMITTALS:

- A. Comply with pertinent provisions of Division 1.
- B. The Manufacturer of vibration isolation products shall submit the following data clearly marked on the submittal drawing. Each piece of isolated equipment shall be clearly identified, as well as the quantity and type of vibration isolators.
 - 1. Weight and center of gravity of each piece of isolation equipment, and RPM of each piece of rotating isolated equipment. When equipment center of gravity is not available, assumed locations for center of gravity shall be identified in submittals.
 - 2. Calculated static load on each isolator.
 - 3. Calculated deflection for each piece of isolated equipment.
- C. Submittals for mountings and hangers incorporating springs shall include spring diameters, rated deflections, spring free height, solid spring height and spring color code.
- D. Submittals for bases shall clearly identify locations for all mountings, as well as all locations for attachment points of the equipment to be mounting base. Installation instructions shall be included.

1.3 QUALITY ASSURANCE:

- A. Product Qualification: Provide each type of vibration isolation unit produced by a specialized manufacturer, with not less than 5 years successful experience in the production of units similar to those for the project.
 - 1. Except as otherwise indicated obtain support isolation units from a single manufacturer.

2. Engage the manufacturer to provide technical supervision of the installation of support isolation units produced by him, and of associated inertia bases.
- B. Manufacturer: Provide vibration isolation mounting units manufactured by the following:
1. Amber/Booth
 2. Consolidated Kinetics Corp.
 3. Vibration Mountings and Controls, Inc./Korfund Dynamics
 4. Mason Industries
 5. Vibration Eliminator Co.
- C. After installation is complete and while the system is operating, the vibration isolation Manufacturer and/or his qualified Representative shall conduct an inspection of the installation with the Contractor. The Representative will submit a written inspection report detailing any discrepancies, the Representative shall submit a report so stating. If there are discrepancies, the report shall detail corrective work to be done.
- 1.4 DESIGN - VIBRATION ISOLATION SYSTEMS:
- A. Vibration isolators shall be selected based on known or estimated operating weight distributions of the isolated equipment, with the quantity and location as shown on the component's drawings. Isolator type shall be tabulated for each isolated piece of equipment.
 - B. Isolators shall have either known non-deflected heights of spring element or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified to determine if the load is within the proper range of the isolator and if the correct degree of vibration isolation is being provided.
 - C. Isolators shall function in the linear portion of the load versus deflection curve. Theoretical vertical natural frequency shall not differ from the design objectives by more than +10%.
 - D. Vibration isolation available internal to the equipment shall not be considered equivalent, and may only be used where it can be shown not to compromise the strength or performance of the entire system.
 - E. Unless otherwise specified, all isolated equipment and all piping and ductwork shall be restrained in accordance with requirements contained herein. All un-isolated mechanical equipment shall be adequately secured to the structure.
 - F. Unless the equipment incorporates unit construction using an integral unit frame or is specified otherwise, each item of mechanical equipment, along with its drive unit, shall be mounted on a rigid steel or steel and concrete base. The equipment, including the base, shall be mounted on, or suspended from, vibration isolators to prevent the transmission of vibration and mechanically transmitted structure-borne sound to the supporting structure.

- G. Isolation hangers shall be used for all piping in equipment rooms or for 50 ft. from vibration equipment, whichever is greater. To avoid reducing the effectiveness of equipment isolators, at least three of the first hangers from the equipment should provide the same deflection as the equipment isolators, with a maximum limitation of 2 inch deflection. The remaining hangers shall be spring or combination spring and rubber with a minimum of 0.75 in deflection. To prevent load transfer to the equipment flanges when the piping system is filled, the first three hangers adjacent to the equipment shall be the positioning type (specification type 5). Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use restrained vibration isolators. They should be selected according to the guidelines for hangers.

PART 2 - PRODUCTS

- 2.1 Unless otherwise specified, all hardware shall be stainless steel or zinc plated. Springs with a deflection of up to 2 inches shall be zinc plated, or coated with a polyester epoxy powder. Springs with a rated deflection capability greater than 2 inches may be painted. Zinc plating shall conform to ASTM B633, Class 2 SC2, minimum.
- 2.2 TYPE 1 MOUNTINGS - DOUBLE DEFLECTION NEOPRENE:
 - A. Double deflection neoprene mountings shall have a minimum rated static deflection of 0.40 inches. Steel top plate and base plate shall be completely bonded and embedded in oil-resistant elastomer. Mountings shall be molded in color for ease of identification of load capacity, and shall have ribbed neoprene surfaces on top and bottom to provide friction pads for those applications which do not need to be bolted to the floor or to equipment. Bolt holes shall be provided on the bottom plate, and a tapped hole on the top, for applications requiring positive tie down.
 - B. Mountings may be combined with steel rails for ease of installation, to compensate for overhung components or for equipment which lack sufficient rigidity for point support.
 - C. Neoprene mountings shall be type RD and steel channel rails type DRB as manufactured by Vibration Mountings and Controls, Inc.
- 2.3 TYPE 2 MOUNTINGS - FLOOR MOUNTED SPRING ISOLATORS:
 - A. Free standing spring-type isolators, shall be laterally stable without housing, snubbers, or guides, and shall include a steel reinforced, ribbed neoprene cup (1/4-inch minimum thickness) between the baseplate and the support.
 - B. Mountings shall have leveling bolts on the top, consisting of an adjusting bolt, cap screw and washer. Mountings shall include a bolt hole in the bottom cup or a two hole rectangular steel baseplate for bolting to the structure. Springs shall not be welded to the baseplate or cup.

- C. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection.
- D. Springs shall have a ratio of horizontal stiffness to vertical stiffness of .75 to 1.25.
- E. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Springs having rated deflection greater than 2 inches may be painted. Hardware shall be stainless steel.
- F. Housed floor isolators shall consist of a telescoping housing containing one or more steel springs as the isolating medium. Isolators shall include resilient inserts to act as upper and lower housing guides, and to prevent metal-to-metal contact providing elastomeric snubbing for side loads. A replaceable neoprene acoustical non-skid pad shall be attached to the bottom of the housing. Mountings shall have built-in leveling bolts and a minimum additional travel to solid equal to 50% of the rated deflection.
- G. Free standing Spring-Flex Mountings shall be Series AC, Series ACB, or Series AWHC as manufactured by Vibration Mountings and Controls, Inc. Housed Spring-Flex Mountings shall be Series B, C, or D as manufactured by Vibration Mountings and Controls, Inc.

2.4 TYPE 3 MOUNTINGS - HOUSED SPRINGS WITH LIMIT STOPS:

- A. Free standing, laterally stable spring-type isolators. Isolators is the same as described in Specification Type 2, except that it includes a housing to provide vertical limit stops to prevent spring extension during weight changes (e.g., draining of fluid from cooling towers and boilers), or when equipment (such as cooling towers) are exposed to uplift loads such as wind loading.
- B. The housing serves as blocking during erection, and shall be located between the equipment and supporting structure. Housing shall be painted or hot dip galvanized. There shall be a minimum clearance of 1/2 inch between the restraining bolts and the housing and spring to prevent interference with spring performance. Limit stops shall be out of contact during normal operation.
- C. Mountings shall have an adjusting bolt on the top of the spring compression plate. Neoprene acoustical non skid pads (1/4 inch minimum thickness) shall be attached to the bottom plate.
- D. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall also have a minimum additional travel to solid equal to 50% of the rated deflection.
- E. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Springs having rated deflection greater than 2 inches may be painted. Hardware shall be stainless steel or zinc plated. Springs shall not be welded to the cups or housings.

- F. Spring-Flex Mountings shall be Series AWR as manufactured by Vibration Mountings and Controls, Inc.

2.5 TYPE 4 MOUNTINGS - SPRING AND RUBBER HANGERS:

- A. Spring-Flex hangers shall consist of a steel spring in series with a .2 inch (minimum) deflection neoprene element. Springs shall be color coded, and elastomer element molded in specific colors for proper identification of rated load capacity. The total static deflection at rated load shall be 1.20 inches.
- B. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
- C. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- D. Spring-Flex hangers shall be series RSH as manufactured by Vibration Mountings and Controls, Inc.

2.6 TYPE 5 MOUNTINGS - SPRING AND RUBBER PRE-POSITIONING HANGERS:

- A. Spring-Flex hangers shall consist of color-coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Hanger design shall incorporate a means for supporting the suspended equipment or piping at a fixed elevation during installation regardless of load changes as well as a means for transferring the load to the spring.
- B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- C. Spring-Flex hangers shall be series RSHP positioning hangers as manufactured by Vibration Mountings and Controls, Inc.

2.7 TYPE 6 MOUNTINGS - SPRING AND RUBBER HANGERS WITH 30 DEGREE MISALIGNMENT CAPABILITY:

- A. Spring-Flex hangers shall consist of a color coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30 degrees before contacting the box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers which are to be used with flat iron duct straps will be provided with eye bolts on both ends.
- B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.

- C. Spring-Flex hangers shall be Series RSH-30A as manufactured by Vibration Mountings and Controls, Inc. Hangers with eyebolts to be type RSHSC as manufactured by Vibration Mountings and Controls, Inc. Hangers with eyebolts to be type RSHSC as manufactured by Vibration Mountings and Controls, Inc.

2.8 TYPE 7 MOUNTINGS - PRE-COMPRESSED HANGERS:

- A. Spring-Flex hangers shall consist of a color coded steel spring in series with a neoprene element molded in specific colors for proper identification of rated load capacity. Springs shall be pre-compressed to the rated deflection so as to support the suspended equipment or piping at a fixed elevation during installation regardless of load changes. For 30 degree misalignment capability, spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30 degrees before contacting the box.
- B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- C. Spring-Flex hangers shall be Series RSHP or RSHP-30A for 30 degree misalignment capability, as manufactured by Vibration Mountings and Controls, Inc.

2.9 TYPE 8 MOUNTINGS - SPRING HANGERS:

- A. Spring-Flex hangers shall consist of a color coded steel spring with a neoprene and steel washer which will properly distribute the load on the spring. For 30 degree misalignment capability, spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing approximately 30 degrees before contacting the box. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers where are to be used with flat iron duct straps will be provided with eye bolts on both ends.
- B. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- C. Spring-Flex hangers shall be Series SH or SH-30A for 30 degree misalignment capability, as manufactured by Vibration Mountings and Controls, Inc. Hangers with eyebolts to be Type SHSC or SHSC-30A for 30 degree misalignment capability, as manufactured by Vibration Mountings and Controls, Inc.

2.10 TYPE 9 MOUNTINGS - HORIZONTAL THRUST RESTRAINTS:

- A. Horizontal Thrust Restraints shall be provided to prevent excessive movement of air handling equipment having air thrust which exceeds 10% of the unit weight. The horizontal thrust restraint shall consist of a steel housing containing a steel spring in series with a neoprene pad. The restraint assembly shall be designed to be pre-adjusted by the manufacturer and permit further adjustment in the field to limit horizontal movement to a maximum of 1/4 inch. Assembly shall be furnished with back up plates

and hardware for attachment to both the equipment and ductwork or structure. Horizontal restraints shall be attached on the centerline of thrust on each side of the unit.

- B. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- C. Springs shall be color coded for proper identification of rated load capacity. Springs shall be coated with a polyester epoxy powder. Hardware shall be stainless steel, or zinc plated. Steel housings shall be painted or galvanized.
- D. Horizontal thrust restraints shall be Series HTR as manufactured by Vibration Mountings and Controls.

2.11 TYPE 10 MOUNTINGS - FLOOR, WALL, AND CEILING SLEEVES:

- A. Where piping passes through walls, floors, or ceilings, a vibration control sleeve shall be provided to reduce the transmission of vibration. The sleeve shall consist of two pipe halves with neoprene sponge material bonded to the inside and a bolting arrangement for secure fit around piping.
- B. Sleeve shall be type VCS as manufactured by Vibration Mountings and Controls, Inc.

2.12 TYPE 11 MOUNTINGS - RESILIENT PIPE GUIDES:

- A. Where vertical piping runs between support points, a resilient pipe guide shall be provided. The guide shall consist of an angle frame and four double deflection neoprene mountings molded in specific colors for proper identification of rated load capacity.
- B. Resilient Pipe Guide shall be type RPG as manufactured by Vibration Mountings and Controls, Inc.

2.13 TYPE 12 MOUNTINGS - PIPE ANCHORS:

- A. Multi-directional pipe anchor shall consist of suitable steel sections in series with heavy duty duck and neoprene material assembled in a telescopic housing to provide the necessary restraint in both the vertical and horizontal directions. Pipe anchor shall be sized to limit load on neoprene and duck material to 500 psi.
- B. Multi-directional Pipe Anchor shall be type MDPA as manufactured by Vibration Mountings and Controls, Inc.
- C. Pipe anchors are not required for grooved piping with flexible couplings.

2.14 TYPE 13 - FLEXIBLE CONNECTORS:

- A. Install Quiet-Sphere Flexible Connectors at the suction and discharge of each pump and inlet and outlet of each chiller, condenser, boiler, cooling tower, and all floor mounted and inline pumps. The connectors shall be molded in spherical design of multiple layers of neoprene and synthetic fiber with integral corrosion resistant plate steel flanges. The connectors shall be suitable for pressures up to 214 psi and temperatures up to 240 degrees F. Where piping is not anchored, control rods must be installed at each connector to limit movement within their specified limits.
- B. Flexible connectors shall be Quiet-Sphere Type VMT, or VMU as manufactured by Vibration Mountings & Controls, Inc.

2.15 BASES AND RAILS:

- A. TYPE C - CONCRETE INERTIA BASE:
 - 1. Concrete Inertia Base Pouring Forms shall be of formed steel members with a depth not less than 1/12 of the longest base dimension, but not less than 6 inches. Height saving isolator mounting brackets shall be bolted or welded to the members. Pouring forms shall include minimum 3/8 inch concrete reinforcing steel (rebar) on 8 inch centers running the length and width of the base. Pouring forms for Split Case Pumps shall be wide enough to support suction and discharge elbows. Anchor bolt templates shall be provided to accept mounting hole location of the supported equipment. Bolted modular designs may be supplied for bases 6" or 10" thick.
 - 2. Bases shall be Type MPF for Modular style or Type WPF for Welded style, as manufactured by Vibration Mountings & Controls, Inc.

PART 3 - EXECUTION

3.1 PERFORMANCE OF VIBRATION ISOLATORS:

- A. The manufacturer shall warrant the selection, sizing, and application of all vibration isolator restraints for each application.

3.2 APPLICATIONS:

- A. General: Except as otherwise indicated, apply the following types of vibration isolator restraints for the indicated items of Equipment.

3.3 VIBRATION ISOLATOR RESTRAINT SCHEDULE

A. EQUIPMENT	TYPE	DEFLECTION
1. Packaged Rooftop Units	D	1.00"
2. Ceiling Fans & Cabinet Heaters	4	0.75"

B. Flexible Duct Connectors: Install at the following ductwork connections:

1. Connections with vibration-isolation-mounted air handling equipment.
2. Connections with fixed wall louvers for air intake and exhausts.

C. Flexible Pipe Connectors: Install in piping systems at the following locations:

1. Connections, 3/4" pipe size and larger, with vibration isolation mounted equipment.

3.4 INSTALLATION:

- A. Isolation systems shall be installed in strict accordance with the Manufacturer's written instructions and submittal data. Locations of all vibration isolation products shall be selected for ease of inspection and adjustment, as well as for proper operation. Electrical and plumbing connections to vibration isolated equipment shall be flexible.
- B. All vibration isolators shall be leveled and aligned squarely below the mounting points of the supported equipment. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft (generally, the long axis) unless this is not possible because of physical restraints.
- C. Unless otherwise indicated, there shall be a minimum operating clearance of 1 inch between inertia bases or structural steel frames and the concrete housekeeping pad or floor beneath the equipment. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.
- D. Vibration isolation hangers shall be positioned as high as possible in the hanger rod assembly, and so that the hanger housings may rotate a full 360 degrees without touching any object. Hanger rods shall not contact any object which would short out the vibration isolation systems. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Do not mix vibration isolated and non-vibration isolated pipes on the same trapeze.
- E. Attention must be paid to movements of piping caused by expansion and contraction.

3.5 EXAMINATION OF RELATED WORK:

- A. Installer of vibration isolation work shall observe the installation of other Work related to vibration isolation work, including work connected to vibration isolation work; and after completion of other related Work (but before Equipment startup), shall furnish a written report to the Engineer listing observed inadequacies for proper operation and performance of vibration isolation work. Report shall cover, but not necessarily be limited to the following:
 1. Equipment installations (performed as Work of other Sections) on vibration isolators.
 2. Piping connections including flexible connections.
 3. Ductwork connections including provisions for flexible connections.

4. Passage of piping and ductwork which is to be isolated through walls and floors.
- B. Do not start up Equipment until inadequacies have been corrected in a manner acceptable to vibration isolation installer.

END OF SECTION 230549

SECTION 230554 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. ANSI Standards: Comply with ANSI A13.1 for lettering size, colors, and viewing angles of identification devices.

1.3 SUBMITTALS:

- A. Product Data: Submit product specifications and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification materials or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags" in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
- D. Provide AutoCAD floor plans showing locations and number designations for valves.

PART 2 - PRODUCTS

2.1 MECHANICAL IDENTIFICATION MATERIALS:

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application the selection is Installer's option. Provide single selection for each product category.

B. Plastic Pipe Markers:

1. General: Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, color coded, plastic-sheet pipe markers, complying with ANSI A13.1.
 - a. Small Pipes: For external diameters 2" and smaller (including insulation if any), provide full-bank pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - 1) Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - b. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
 - c. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastics.

C. Valve Tags:

1. Engraved plastic tags: Provide laminated three-layer with engraved black letters on light contrasting background color. Piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
2. Provide 1-1/2" diameter tags, except as otherwise indicated.

D. Valve Tag Fasteners: Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

E. Valve Schedule Frames:

1. General: For each page of the valve schedule, provide a glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

F. Engraved Plastic-Laminate Signs:

1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and working indicate, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
 - a. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substance.
3. Letter Size: 3"

G. Manufacturer:

1. General: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
 - a. Brady (W.H.) Company, Signmark Div.

- b. Seton Name Plate Corp.

2.2 LETTERING AND GRAPHICS:

- A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or schedule. Provide numbers, lettering and working as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.
1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples: Boiler No. 3, Air Supply No. 1H, Standpipe F12).
 2. Coordinate valve tag numbering with existing valve tag schedules. Duplicate numbering shall not occur.

2.3 APPLICATION AND INSTALLATION:

A. General Installation Requirements:

1. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of coverings and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:

1. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
 - a. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
2. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces.
3. Near each valve and control device.
 - a. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
4. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
5. At access doors, manholes and similar access points which permit view of concealed piping.
6. Near major equipment items and other points of origination and termination.
 - a. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

8. For HVAC piping, use green background with white letters. Submit all designations prior to installation for approval and the following designations.
 - a. Hot water supply HWS
 - b. Hot water Return HWR

C. Valve Identification:

1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, and HVAC terminal devices. List each tagged valve in valve schedule for each piping system.
2. Mount valve schedule frames and schedules in machine rooms where indicated or, of not otherwise indicated, where directed by Architect/Engineer.

D. Mechanical Equipment Identification: Provide marker on ceiling grid below VAV boxes, fan coils, etc. with equipment ID numbers.

1. General: Install engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Pumps and similar motor-driven units.
 - c. Heat exchangers, coils evaporators, and similar equipment.
 - d. Fans.
 - e. HVAC central-station units.
 - f. Tanks and pressure vessels.
 - g. Air Handling Units
 - h. Unit ventilators
 - i. Chillers
 - j. Cooling Tower
 - k. Boilers
 - l. Exhaust Fans

PART 3 - EXECUTION

3.1 Mechanical Identification:

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.

- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8" below finished grade, directly above buried pipe.
- F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices. Small devices, such as in-line pumps, may be identified with tags.
- G. Identify control panels and major control components outside panels with plastic nameplates.
- H. Identify thermostats relating to terminal boxes or valves with nameplates.
- I. Identify valves in main and branch piping with tags.
- J. Identify air terminal units and radiator valves with numbered tags.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.
- L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4" diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20' on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- M. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
- N. Provide Valve Identification Chart. Post framed chart in Boiler Room.

END OF SECTION 230554

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Testing, adjusting and balancing shall be performed by an independent TAB agency that shall be hired by the Mechanical Contractor.
- B. This contractor shall assist the balancer in balancing the HVAC system in phases. Include all time required to assist the balancer in the completion of his work.

1.2 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Sound measurement of equipment operating conditions.
- E. Vibration measurement of equipment operating conditions.

1.3 REFERENCES

- A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council; 2002.
- B. ASHRAE Std 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 1988, with 1997 Errata.
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting Balancing of Environmental Systems; National Environmental Balancing Bureau; 2005, Seventh Edition.
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association; 2002.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.

- B. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
1. Submit to Architect.
 2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 4. Include at least the following in the plan:
 - a. Preface: An explanation of the intended use of the control system.
 - b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.
 - g. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - h. Expected problems and solutions, etc.
 - i. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
 - j. Details of how TOTAL flow will be determined; for example:
 - 1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - 2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - l. Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - n. Method of checking building static and exhaust fan and/or relief damper capacity.

- o. Proposed selection points for sound measurements and sound measurement methods.
 - p. Methods for making coil or other system plant capacity measurements, if specified.
 - q. Time schedule for TAB work to be done in phases (by floor, etc.).
 - r. Description of TAB work for areas to be built out later, if any.
 - s. Time schedule for deferred or seasonal TAB work, if specified.
 - t. False loading of systems to complete TAB work, if specified.
 - u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - v. Interstitial cavity differential pressure measurements and calculations, if specified.
 - w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - x. Procedures for formal progress reports, including scope and frequency.
 - y. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
- E. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations. In addition to the hard copy, provide an electric copy for record.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 6. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE Std 111, or NEBB forms.
 - 7. Include the following on the title page of each report:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone number of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.
 - h. Project Contractor.

- i. Report date.

1.5 QUALITY ASSURANCE

- A. Perform total system balance in accordance with AABC MN-1, ASHRAE Std 111, or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
 - 1. Maintain one copy of each document on site.
- B. TAB Agency Qualifications: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum three years documented experience certified by AABC or NEBB.
- C. Perform Work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor experienced in performance of this Work and licensed at the Pennsylvania.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform system balance in accordance with one of the following:
 - 1. AABC MN-1, AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
 - 4. SMACNA HVAC Systems Testing, Adjusting, and Balancing.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:

- a. AABC, Associated Air Balance Council: www.aabchq.com; upon completion submit AABC National Performance Guaranty.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 TESTING, ADJUSTING, AND BALANCING AGENCIES

- A. H.T. Lyons,
- B. Butler Balancing.
- C. Associated Air Balance Engineers.
- D. Optimum Performance Balancing

3.3 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place.
 - 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- C. Beginning of work means acceptance of existing conditions.
- D. Interconnected pumping systems will require various balancing efforts throughout the phases. This contract includes all of these visits as required to achieve the designed phasing.

3.4 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. Check and adjust systems approximately six months after final acceptance and submit report.

3.6 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.7 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

- 1. Manufacturer
- 2. Model/Frame
- 3. HP/BHP
- 4. Phase, voltage, amperage; nameplate, actual, no load
- 5. RPM
- 6. Service factor
- 7. Starter size, rating, heater elements
- 8. Sheave Make/Size/Bore

B. V-Belt Drives:

- 1. Identification/location
- 2. Required driven RPM
- 3. Driven sheave, diameter and RPM
- 4. Belt, size and quantity
- 5. Motor sheave diameter and RPM
- 6. Center to center distance, maximum, minimum, and actual

C. Pumps:

- 1. Identification/number
- 2. Manufacturer
- 3. Size/model
- 4. Impeller
- 5. Service
- 6. Design flow rate, pressure drop, BHP
- 7. Actual flow rate, pressure drop, BHP
- 8. Discharge pressure
- 9. Suction pressure
- 10. Total operating head pressure
- 11. Shut off, discharge and suction pressures
- 12. Shut off, total head pressure

D. Combustion Equipment:

1. Boiler manufacturer
2. Model number
3. Serial number
4. Firing rate
5. Overfire draft
6. Gas meter timing dial size
7. Gas meter time per revolution
8. Gas pressure at meter outlet
9. Gas flow rate
10. Heat input
11. Burner manifold gas pressure
12. Percent carbon monoxide (CO)
13. Percent carbon dioxide (CO₂)
14. Percent oxygen (O₂)
15. Percent excess air
16. Flue gas temperature at outlet
17. Ambient temperature
18. Net stack temperature
19. Percent stack loss
20. Percent combustion efficiency
21. Heat output

E. Air Cooled Condensers:

1. Identification/number
2. Location
3. Manufacturer
4. Model number
5. Serial number
6. Entering DB air temperature, design and actual
7. Leaving DB air temperature, design and actual
8. Number of compressors

F. Chillers:

1. Identification/number
2. Manufacturer
3. Capacity
4. Model number
5. Serial number
6. Evaporator entering water temperature, design and actual
7. Evaporator leaving water temperature, design and actual
8. Evaporator pressure drop, design and actual
9. Evaporator water flow rate, design and actual
10. Condenser entering water temperature, design and actual
11. Condenser pressure drop, design and actual
12. Condenser water flow rate, design and actual

H. Cooling Coils:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Entering air DB temperature, design and actual
7. Entering air WB temperature, design and actual
8. Leaving air DB temperature, design and actual
9. Leaving air WB temperature, design and actual
10. Water flow, design and actual
11. Water pressure drop, design and actual
12. Entering water temperature, design and actual
13. Leaving water temperature, design and actual
14. Saturated suction temperature, design and actual
15. Air pressure drop, design and actual

H. Heating Coils:

1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Water flow, design and actual
7. Water pressure drop, design and actual
8. Entering water temperature, design and actual
9. Leaving water temperature, design and actual
10. Entering air temperature, design and actual
11. Leaving air temperature, design and actual
12. Air pressure drop, design and actual

I. Air Moving Equipment:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Arrangement/Class/Discharge
6. Air flow, specified and actual
7. Return air flow, specified and actual
8. Outside air flow, specified and actual
9. Total static pressure (total external), specified and actual
10. Inlet pressure
11. Discharge pressure
12. Sheave Make/Size/Bore
13. Number of Belts/Make/Size
14. Fan RPM

J. Return Air/Outside Air:

1. Identification/location
2. Design air flow
3. Actual air flow
4. Design return air flow
5. Actual return air flow
6. Design outside air flow
7. Actual outside air flow
8. Return air temperature
9. Outside air temperature
10. Required mixed air temperature
11. Actual mixed air temperature
12. Design outside/return air ratio
13. Actual outside/return air ratio

K. Exhaust Fans:

1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Air flow, specified and actual
6. Total static pressure (total external), specified and actual
7. Inlet pressure
8. Discharge pressure
9. Sheave Make/Size/Bore
10. Number of Belts/Make/Size
11. Fan RPM

L. Duct Traverses:

1. System zone/branch
2. Duct size
3. Area
4. Design velocity
5. Design air flow
6. Test velocity
7. Test air flow
8. Duct static pressure
9. Air temperature
10. Air correction factor

M. Duct Leak Tests:

1. Description of ductwork under test
2. Duct design operating pressure
3. Duct design test static pressure
4. Duct capacity, air flow
5. Maximum allowable leakage duct capacity times leak factor
6. Test apparatus
 - a. Blower

- b. Orifice, tube size
- c. Orifice size
- d. Calibrated
- 7. Test static pressure
- 8. Test orifice differential pressure
- 9. Leakage

N. Terminal Unit Data:

- 1. Manufacturer
- 2. Type(constant, variable, fan powered, single, dual duct)
- 3. Identification/number
- 4. Location
- 5. Model number
- 6. Size
- 7. Minimum static pressure
- 8. Minimum design air flow
- 9. Maximum design air flow
- 10. Maximum actual air flow
- 11. Inlet static pressure

O. Air Distribution Tests:

- 1. Air terminal number
- 2. Room number/location
- 3. Terminal type
- 4. Terminal size
- 5. Area factor
- 6. Design velocity
- 7. Design air flow
- 8. Test (final) velocity
- 9. Test (final) air flow
- 10. Percent of design air flow

P. Sound Level Reports:

- 1. Location
- 2. Octave bands - equipment off
- 3. Octave bands - equipment on

Q. Vibration Tests:

- 1. Location of points:
 - a. Fan bearing, drive end
 - b. Fan bearing, opposite end
 - c. Motor bearing, center (if applicable)
 - d. Motor bearing, drive end
 - e. Motor bearing, opposite end
 - f. Casing (bottom or top)
 - g. Casing (side)
 - h. Duct after flexible connection (discharge)

- i. Duct after flexible connection (suction)
- 2. Test readings:
 - a. Horizontal, velocity and displacement
 - b. Vertical, velocity and displacement
 - c. Axial, velocity and displacement
- 3. Normally acceptable readings, velocity and acceleration
- 4. Unusual conditions at time of test
- 5. Vibration source (if non-complying)

END OF SECTION 230593

SECTION 230714 - HVAC DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Duct Liner.

1.2 RELATED SECTIONS

- A. Section 23 0554 - Identification for HVAC Piping and Equipment.

1.3 REFERENCES

- A. ASTM C 553 - Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2002.
- B. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2004.
- C. ASTM C 1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2005.
- D. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.
- E. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- F. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- G. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; 2003.
- I. IECC 2018 - International Energy Conservation Code.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.
- D. Submit MSS information for all products.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than five years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.
- C. Store indoors or in suitable storage facilities. Do not store outdoors.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.
- C. All insulation and adhesives shall be formaldehyde free.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 GLASS FIBER, FLEXIBLE

A. MANUFACTURER:

1. Johns Manville Corporation: www.jm.com. Microlite XG.
 - a. Approved formaldehyde-free equal.
2. Insulation: ASTM C 553-92; formaldehyde-free, flexible glass fiber, noncombustible blanket.
 - a. 'K' ('Ksi') value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C 518.
 - 1) Maximum Service Temperature: 450 degrees F (232 degrees C).
 - 2) Maximum Water Vapor Sorption: 5.0 percent by weight.
3. Vapor Barrier Jacket:
 - a. Porous interior sealant primers shall not have VOC content in excess of 775 grams/liter, less water and compounds exempt by the applicable LEED standard.
 - b. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - c. Moisture Vapor Permeability: 0.058 ng/Pa s m, when tested in accordance with ASTM E 96/E 96M.
 - d. Secure with pressure sensitive tape.
4. Vapor Barrier Tape:
 - a. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive formaldehyde-free rubber based adhesive.

2.3 GLASS FIBER, RIGID

A. Manufacturer:

1. Knauf Fiber Glass: www.knauffiberglass.com.
2. Johns Manville Corporation: www.jm.com.
3. Owens Corning Corp: www.owenscorning.com.
4. CertainTeed Corporation: www.certainteed.com.

B. Insulation: ASTM C 612; rigid, noncombustible blanket.

1. 'K' ('Ksi') value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C 518.
2. Maximum service temperature: 450 degrees F (232 degrees C).
3. Maximum Water Vapor Sorption: 5.0 percent.
4. Maximum Density: 8.0 lb/cu ft (128 kg/cu m).
5. Vapor Barrier Jacket:
 - a. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - b. Moisture Vapor Permeability: 0.058 ng/Pa s m, when tested in accordance with ASTM E 96/E 96M.
 - c. Secure with pressure sensitive tape.

2.4 DUCT LINER

A. Manufacturers:

1. Knauf Fiber Glass: www.knauffiberglass.com.
2. Approved equal.

B. Flexible, mat-faced bonded insulation with encapsulated edge coating.

1. Thermal Performance: 1.5" thickness; R-value 6.0 (hr-sqft-F/Btu).
2. Service temperature: up to 250 degrees F.
3. Rated velocity on coated side for air erosion: 6,000 fpm minimum.
4. Minimum noise reduction coefficients: 1.5 inch thickness; 0.80.

C. Liner Fasteners: Galvanized steel, welded with integral head.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Insulated ducts conveying air below ambient temperature:
 1. Provide insulation with vapor barrier jackets.
 2. Finish with tape and vapor barrier jacket.
 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
 5. Insulated ducts conveying air above ambient temperature:
 - a. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. External Duct Insulation Application:
 1. Install without sag on underside of duct. Use welded pin mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.

2. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
3. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
4. Install Insulation materials with smooth and even surfaces.
5. Maintain integrity of vapor barrier on ductwork insulation, and protect it to prevent puncture and other damage.
6. Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations except where otherwise indicated.

E. Duct and Plenum Liner Application:

1. Adhere insulation with adhesive for 100 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for spacing.
3. Seal and smooth joints. Seal and coat transverse joints.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 PROTECTION AND REPLACEMENT:

- A. Replace damaged insulation, which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: The installer of the ductwork insulation shall advise the contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.4 SCHEDULES

- A. All fresh air intake ducts from the outside intake louver or vent to the unit casing shall be externally insulated with 2" thick fiberglass.
- B. All exhaust and relief air ducts from the backdraft device to the louver shall be externally insulated with 1.5" thick fiberglass.
- C. Transfer air ducts shall be acoustically (internally) lined with 1" thick liner where indicated on the plans.
- D. All supply and return air ductwork of air conditioning systems shall be externally insulated unless noted to be internally lined (except where ductwork is installed exposed in the conditioned space). Exposed and partially exposed ductwork shall be lined unless noted otherwise.
- E. Where ducts are internally lined for acoustical treatment, no additional outside duct insulation shall be required.

F Dual Temperature Ductwork:

1. Application Requirements: Where leaving air temperature is alternately above and below ambient temperature insulate and vapor seal ductwork, except where ductwork is indicated to be acoustically lined.
2. Externally Insulated Ductwork: Provide with one of the following types and thicknesses of insulation, except as otherwise indicated:
 - a. Insulation: Rigid mineral fiber, 6 PCF in exposed areas, 1.5" thick with a minimum installed "R" value of 6.0.
 - b. Insulation: Flexible mineral fiber, 2" thick, application limited to concealed locations. Density shall be 1.5 pounds/cubic foot with a minimum installed "R" value of 6.0.
 - c. Bottoms of all insulated ducts over 18" wide shall have rigid insulation fastened with welded pins.

H. Lined Ductwork:

1. 1.5" thick duct liner for supply and return air ductwork where duct liner is indicated on the drawings.
2. All transfer ducts shall be lined with 1" thick liner.

END OF SECTION 230714

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.2 RELATED SECTIONS

- A. Section 07 8400 - Firestopping
- B. Section 23 2113 - Hydronic Piping
- C. Section 23 2300 - Refrigerant Piping

1.3 REFERENCES

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2007.
- C. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus; 2004.
- D. ASTM C 195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007.
- E. ASTM C 449/C 449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2000.
- F. ASTM C 533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2009.
- G. ASTM C 534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2007a.
- H. ASTM C 547 - Standard Specification for Mineral Fiber Pipe Insulation; 2007.
- I. ASTM C 552 - Standard Specification for Cellular Glass Thermal Insulation; 2007.

- J. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2009.
- K. ASTM C 585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System); 2009.
- L. ASTM C 591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2009.
- M. ASTM C 610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation; 2009.
- N. ASTM C 795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008.
- O. ASTM D 1056 - Standard Specification for Flexible Cellular Materials--Sponge or Expanded Rubber; 2007.
- P. ASTM D 2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2006.
- Q. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010.
- R. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- S. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.
- T. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- U. IECC 2018 - International Energy Conservation Code.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than five years of documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 GLASS FIBER

- A. Manufacturers:
 - 1. Knauf Insulation: www.knaufusa.com.
 - 2. Johns Manville Corporation: www.jm.com.
 - 3. Owens Corning Corp: www.owenscorning.com.
 - 4. CertainTeed Corporation: www.certainteed.com.
- B. Insulation: ASTM C 547 and ASTM C 795; rigid molded, noncombustible.
 - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 850 degrees F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- C. Insulation: ASTM C 547 and ASTM C 795; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum service temperature: 650 degrees F.
 - 3. Maximum moisture absorption: 0.2 percent by volume.

- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96/E 96M of 0.02 perm-inches.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:

- 1. Armacell International: www.armacell.com.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C 534 Grade 3; use molded tubular material wherever possible.

- 1. Minimum Service Temperature: -40 degrees F.
- 2. Maximum Service Temperature: 220 degrees F.
- 3. Connection: Waterproof vapor barrier adhesive.

2.4 JACKETS

A. PVC Plastic.

1. Manufacturers:

- a. Johns Manville Corporation: www.jm.com.
- b. Owens Corning Corp..
- c. Knauf Insulation.

2. Jacket: One piece molded type fitting covers and sheet material, off-white color.

- a. Minimum Service Temperature: 0 degrees F.
- b. Maximum Service Temperature: 220 degrees F.
- c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E 96/E 96M.
- d. Thickness: 10 mil.
- e. Connections: Brush on welding adhesive. Tape all joints in addition to adhesive.
- f. Match

B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.

- 1. Thickness: 0.016 inch sheet.
- 2. Finish: Smooth.
- 3. Joining: Longitudinal slip joints and 2 inch laps.
- 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
- 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- E. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel, minimum 18 gauge) between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- F. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.
- G. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- H. General: Install insulation products in accordance with the manufacturer's written instructions, and in accordance with the recognized industry practices to ensure that the installation serves its intended purpose.
- I. Install insulation of pipe systems subsequent to testing and acceptance of tests.

- J. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full length units of insulation, with a single cut piece to complete the run. Do not cut pieces of scraps abutting each other.
- K. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- L. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at installer's option) except where a specific form or type is indicated. Valves in chilled water systems shall be insulated with removable factory pre-molded insulators. Any condensation problems shall be corrected by the Contractor. Damage to finishes caused by condensation shall be corrected by this Contractor.
- M. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
- N. Pipe Hanger Insulation Inserts: Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3 inch wide vapor barrier stage or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inch wide vapor barrier tape or band.
- O. Replace damaged insulation which cannot be repaired satisfactorily including units with vapor barrier damage and moisture saturated units.
- P. Protection: Insulation Installer shall advise the Contractor of required protection for the insulation work during the remainder of the construction period to avoid damage and deterioration.

3.3 SCHEDULE

A. HVAC Systems:

- 1. Hot Low Pressure Piping (to 200 Deg. F. (93 Deg. C.):
 - 1) Application Requirements: Insulate the following hot low pressure HVAC piping systems.
 - a) HVAC hot water supply and return piping.
 - 2) Insulate each piping system specified above with one of the following types and thickness of insulation:
 - a) Insulation: Fiberglass; 1 1/2" thick for pipe sizes up to and including 1 1/4" in diameter. 2" thick for pipe sizes 1 1/2" in diameter and larger.
 - b) Outdoor Application: Increase insulation thickness by 1 inch. Cover with 22 gauge corrugated aluminum with all joints sealed watertight.

END OF SECTION 230719

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements, (if any), apply to the work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. The extent of the electric/electronic Direct Digital Control temperature control work is indicated by drawings and schedules and by the requirements of this section.
- B. Control sequence is hereby defined to mean the manner in which, and methods by which, the automatic temperature controls function. The requirements for each type of operation are specified in this section.
- C. The control system shall be an extension of the existing Owen J Roberts District Service Center's BAS. All new controllers and software shall match existing or be the latest version of existing.

1.3 GENERAL:

- A. The temperature control contractor shall furnish all material, equipment and services necessary for the proper installation of an electric/electronic system of automatic temperature controls. Temperature control equipment information & shop drawings of the entire control system shall be submitted to the Engineer for approval, prior to commencement of work.
- B. After completion of the installation, the automatic temperature control contractor shall adjust all thermostats, control dampers, motors and other equipment provided under his contract with trained personnel in the direct employ of the temperature control contractor. The control system as shown on the Drawings and specified herein shall be guaranteed free from defects in workmanship and materials under normal use and service for a period of one year, after acceptance by the Engineer and/or Owner. The contractor shall return during off season to verify seasonal functions are working properly.
- C. Any equipment herein described proved to be defective in workmanship or material during the guarantee period shall be adjusted, repaired or replaced by the automatic temperature control contractor at no charge to the Owner. Instructions shall be given to Owner's personnel.

1.4 SCOPE OF WORK:

- A. The Building Automation System (BAS) contractor shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems as herein specified. Complete temperature control system as specified herein. The installation of the control system shall be performed under the direct supervision of the controls contractor with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing contractor shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.
- B. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specifically for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- C. BAS contractor shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.
- D. The extension of BAS system shall be done in a way to maintain the original form and function as the existing system. The head end shall be programmed to maintain same points and controllers shall be mapped the same way. An Owner meeting shall be held prior to system design to make sure desired points/functions are available. Coordinate meeting with Architect/Engineer.

1.5 COORDINATION OF WORK:

- A. Mechanical contractor installs all wells, valves, taps, dampers, flow stations, etc. furnished by BAS subcontractor.
- B. Electrical Contractor provides:
 - 1. 120 volt power wiring and data where shown on the drawings. Any additional 120V power as required for all controls operations and devices shall be provided by the BAS contractor as part of the contract.
 - 2. Wiring of all power feeds through all disconnect starters to electrical motor.
 - 3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS contractor.
- C. Products furnished but not installed under this section:
 - 1. Section 23 2113 Hydronic Piping:
 - a. Control Valves
 - b. Flow Switches

- c. Temperature Sensor Wells and Sockets
- d. Flow Meters
- 2. Section 23 3100 - Duct-work Accessories:
 - a. Automatic Dampers
 - b. Air-flow Stations
 - c. Terminal Unit Controls

1.6 QUALITY ASSURANCE

- A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. contractor shall have an in-place support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.
- B. The contractor shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BAS.
- C. The Bidder shall be regularly engaged in the manufacturing, installation, and maintenance of the specified BAS systems, and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of B.M.S. systems similar in size and complexity to this project. The Bidder must also have and maintain a service organization consisting of at least ten (10) competent servicemen for a period of not less than ten years and the provide a list of 10 projects, similar in size and scope to this project completed within the last five years.
- D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- E. BAS shall comply with UL 916 PAZX and 864 UDTZ, ULC, and other subsystem listings as applicable, and herein specified, and be so listed at the time of bid.
- F. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- G. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

- H. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.7 SUBMITTALS

- A. Provide submittals for fast-track items that need to be approved and released to meet the schedule of the project. Provide submittals for the following items separately upon request:
 - 1. Valve schedule and product data
 - 2. Damper schedule and product data
 - 3. Mounting and wiring diagrams for factory-installed control components
- B. Provide a complete submittal with all controls system information for approval before construction starts. Include the following:
 - 1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.
 - 3. Details of control panel faces, including sizes, controls, instruments, and labeling.
 - 4. Schedule of dampers and actuators including size, leakage, and flow characteristics. If dampers are furnished by other, submit a damper actuator schedule coordinating actuator sizes with the damper schedule.
 - 5. Schedule of valves including leakage and flow characteristics.
 - 6. Written description of the Sequence of Operations.
 - 7. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs and repeaters.
 - 8. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 9. Submit BACnet Protocol Implementation Conformance Statements (PICS) for all direct digital controllers, software and other system components that will communicate on the BAS utilizing BACnet.

- C. Submit a description of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.
- D. Variance letter: Submit a letter detailing each item in the submission that varies from the contract specification or sequence of operation in any way.

1.8 QUALITY ASSURANCE

A. Codes

1. Perform all wiring in accordance with Division 26, NEC, local codes and Owner's requirements.
2. 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.
3. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
4. Comply with ASHRAE 135-2010 BACnet: A Data Communication Protocol for Building Automation and Control Networks.
5. Comply with ASHRAE 90.1- 2007, 2010, 2013 Energy Standard for Buildings Except Low-Rise Residential Buildings.
6. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards, including UL 916 - PAZX Energy Management Systems,
 - 1) Provide written approvals and certifications after installation has been completed.
7. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

B. Qualifications

1. Installing contractor shall be in the business of installing and servicing DDC controls for mechanical systems, temperature and ventilation control, environmental control, lighting control, access and security, life safety and energy management as their primary business.
2. Installer Qualifications: An experienced installer who is the authorized representative of the automatic control system manufacturer for both installation and maintenance of controls required for this Project.
3. Engineering, drafting, programming, and graphics generation shall be performed by the local branch engineers and technicians directly employed by the Building Automation System Contractor.
4. Supervision, checkout and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.

- C. The BAS contractor shall maintain a service organization consisting of factory trained service personnel and provide a list of ten (10) projects, similar in size and scope to this project, completed within the last five years.

- D. Final determination of compliance with these specifications shall rest solely with the Engineers and Owner who will require proof of prior satisfactory performance.
- E. All portions of the system must be designed, furnished, installed, commissioned and serviced by manufacturer approved, factory trained employees.

1.9 WARRANTY

- A. Conform to the warranty requirement of the Contract Documents, General Requirements and this section or a minimum of 12 months. This warranty shall apply equally to both hardware and software.
- B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system demonstration.
- C. Hardware and software personnel supporting this warranty agreement shall provide on-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.
- D. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.

1.10 COORDINATION

- A. Coordinate IP drops, network connections, user interfaces, firewall, etc with Owner's IT representative.
- B. Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.
- C. Coordinate power for control units and operator workstation with electrical contractor.
- D. Coordinate installation of taps, valves, airflow stations, etc. with the mechanical contractor.

1.11 APPROVED CONTROL SYSTEM MANUFACTURERS

- A. Base Bid: JCI Metasys Controls by local branch Office.
- B. Alternate Bid: Distech controls by Conexus or Dynatech.
- C. Alternate Bid: Schneider Electric controls by Tri-M.

PART 2 - PRODUCTS

2.1 GRAPHICAL USER INTERFACE

- A. Provide system color graphics for each HVAC system or piece of mechanical equipment that is monitored and/or controlled by the BAS. Provide scaled floor plans indicating equipment location, service, and system data as required.
- B. Provide a separate dynamic display page of each piece mechanical equipment (Chilled Water System, Hot Water System, etc.) connected to the BAS.
- C. All control set points shall be easily adjustable from the system's color graphic screen by operators with the proper access level. Each controlled point on the BAS operator workstation color graphic screens shall have the set point indicated along with the actual controlled variable reading. All points shall indicate engineering units as required by the application.

2.2 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.
- B. Install new wiring and network devices as required to provide a complete and workable control network.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 23 09 93. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Workstations, Building Control Panels, and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.

- F. System shall be expandable to at least 10% the required input and output objects with additional controllers, associated devices, and wiring.
- G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.
 - 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 - 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 - 3. For read or write requests, the system shall require username and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.

2.3 OPERATOR INTERFACE

A. Hardware.

- 1. Workstation: Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified elsewhere in this document. The following hardware requirements also apply:
 - a. The hard disk shall have sufficient memory to store:
 - 1) All required operator workstation software.
 - 2) A DDC database at least twice the size of the delivered system database.
 - 3) One year of trend data based on the points specified to be trended at their specified trend intervals.
 - b. Provide additional hardware (communication ports, video drivers, network interface cards, cabling, etc.) to facilitate all control functions and software requirements specified for the DDC system.
 - c. Hardware configuration shall be: HP Z2 Tower G9 Workstation
 - 1) Windows 11 Pro, WSL2 operating systems
 - 2) Intel® Core™ i9-14900 5.4 GHz.
 - 3) Memory - 64 GB DDR5-4800 MT/s (2 x 32 GB)
 - 4) 1 TB HP Z Turbo Drive PCIe® Gen4 TLC M.2 SSD.
 - 5) Integrated: Intel® UHD Graphics 770

B. System Software.

- 1. Operating System. Web server or workstation shall have an industry-standard professional-grade operating system. Operating system shall meet or exceed the DDC System manufacturer's minimum requirements for their software.
- 2. System Graphics: (Metasys UI) All new graphics shall be created on the newest graphics platform available...ie Metasys UI graphics, not GGT graphics. The operator interface software shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water

and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

- a. **Functionality.** Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - b. **Animation.** Graphics shall be able to animate by displaying different image files for changed object status.
 - c. **Alarm Indication.** Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. **Format.** Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in or shall only require widely available no-cost plug-ins (such as Adobe Flash).
3. **Custom Graphics.** Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in the same formats as are used for system graphics.
 4. **Graphics Library.** Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
- C. **System Applications.** System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.
1. **Automatic System Database Configuration.** Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
 2. **Manual Controller Memory Download.** Operators shall be able to download memory from the system database to each controller.
 3. **System Configuration.** The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Operators shall be able to configure the system.
 4. **On-Line Help.** Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 5. **Security.** Each operator shall be required to log on to the system with user name and password in order to view, edit, add, or delete data.

- a. Operator Access. The user name and password combination shall define accessible viewing, editing, adding, and deleting privileges for that operator. Users with system administrator rights shall be able to create new users and edit the privileges of all existing users. System Administrators shall also be able to vary and deny each operator's privileges based on the geographic location of the equipment, such as the ability to edit operating parameters in Building A, to view but not edit parameters in Building B, and to not even see equipment in Building C.
 - b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. This auto logoff time shall be user adjustable.
 - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics. The system shall automatically monitor the operation of all building management panels and controllers. The failure of any device shall be annunciated to the operator.
 7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93 (Sequences of Operation). Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
 8. Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying on acronyms or mnemonics.
 9. Alarm Reactions. Operator shall be able to configure (by object) what, if any actions are to be taken during an alarm. As a minimum, the workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
 10. Alarm and Event log. Operators shall be able to view all system alarms and changes of state from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and delete alarms, and archive closed alarms to the workstation or web server hard disk.
 11. Trend Logs. The operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 23 09 93 (Sequences of Operation). Trends shall be BACnet trend objects.
 12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object or property in the system. The status shall be available by menu, on graphics, or through custom programs.
 13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
 14. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.

- b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - 1) Alarm History.
 - 2) Trend Data. Operator shall be able to select trends to be logged.
 - 3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
- D. Workstation Application Editors. Each PC or browser workstation shall support editing of all system applications. The applications shall be downloaded and executed at one or more of the controller panels.
- 1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.
 - 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and schedule type. Exception schedules and holidays shall be shown clearly on the calendar. The start and stop times for each object shall be adjustable from this interface.
 - 3. Custom Application Programming. Provide the tools to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.
 - b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
 - c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
 - d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
 - e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

- f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
 - g. Variables. Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 1) Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 2) System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
- E. Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

2.4 WIRING AND RACEWAYS

- A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

2.5 ACTUATORS AND OPERATORS

- A. General Requirements
 - 1. Actuators shall be electronic, as detailed in the following sections.
 - 2. The manufacturer shall be ISO 9001 certified.
 - 3. Requirements for positive spring return to a fail-safe normally open or closed position shall be as specified within the sequences of operations and/or I/O summaries. If no fail-safe operation is specified, actuators shall fail in their last commanded position.
- B. Electronic Damper Actuators
 - 1. Spring Return Actuators:
 - a. Spring Return Actuators shall be manufactured, brand labelled and distributed by Johnson Controls or an approved equivalent.
 - b. Spring Return Actuators shall comply with the following regulatory agency listings: cULus, CSA C22.2 No24-93, and CE marked. Asia Pacific (APAC) actuators shall be excluded from this regulatory information.

- c. Spring Return Actuators shall be of direct-coupled design and require no crank arm or linkage for mounting to a shaft.
- d. Spring Return Actuators shall offer a coupling method which requires a toothed V-bolt clamp and nuts with toothed cradle.
- e. Spring Return Actuators shall be configured for reversible mounting which provides either clockwise or counterclockwise operation.
- f. Spring Return Actuators power failure operation shall configure upon a loss of electric power to the actuator, a mechanical spring return system shall drive the actuator to the failsafe home position. Other forms of internal energy storage for power failure operation shall not be acceptable.
- g. Spring Return Actuators shall utilize the following motor technology:
 - 1) Modulating types: Microprocessor-controlled brushless DC motors
 - 2) On/Off types: DC brush motor
- h. Spring Return Actuators shall be furnished with Electronic Stall Detection which protects the actuator from overload at all angles of rotation without the need for end switches.
- i. Spring Return Actuators shall comply with enclosure ratings of NEMA type 2 or IP54 mounted in any orientation.
- j. Spring Return Actuators shall eliminate the need for electrical ground wires for double-insulated construction.
- k. Spring Return Actuators shall be furnished with integral cables with colored and numbered conductors for simplified wiring.
- l. Spring Return Actuators shall be sized for the torque required to seal the damper at load conditions.
- m. Spring Return Actuators shall be available in parallel operation that are capable of being mechanically or electrically paralleled.
- n. Proportional actuators shall be user configurable without the use of external computer software or programming tools. Calibration, input signal range selection, and control logic reversal shall be selectable with an external mode selection switch.
- o. Spring Return Actuators shall operate in the following temperature ranges:
 - 1) For a 70 lb·in. torque actuator range must be -40°F to 140°F (-40°C to 60°C)
 - 2) For a 177 lb·in. torque actuator range must be -40°F to 131°F (-40°C to 55°C)
- p. Spring Return Actuators shall be provided with the following power requirements:
 - 1) Modulating types:
 - a) A torque of 27 lb·in. has a 6VA maximum
 - b) A torque of 70 lb·in. has an 8VA maximum
 - c) A torque of 177 lb·in. has a 16VA maximum
 - d) Two-position types:
 - e) A torque of 27 lb·in. has a 6VA maximum
 - f) A torque of 70 lb·in. has an 8VA maximum
 - g) A torque of 177 lb·in. has a 25VA maximum

2. Non-Spring Return Actuators

- a. Non-Spring Return (NSR) actuators shall be manufactured, brand labelled or distributed by Johnson Controls or an approved equivalent. The NSR actuators are manufactured under International Standards Organization (ISO) 9001 Quality Control Standards to ensure quality.
- b. NSR actuators shall comply with the following regulatory agency listings: cULus, CSA C22.2 No 24-93, and CE marked. APAC actuators are excluded from this regulatory information.
- c. NSR actuators shall be provided with a 5-year warranty from the date of sale. Actuators sold in the APAC region shall comply with an 18-month warranty policy.
- d. NSR actuators shall be of direct-coupled design and require no crank arm or linkage for mounting to a shaft.
- e. NSR actuators shall be of a design that converts the damper version to the valve version without the use of special tools.
- f. NSR actuators shall be configured for direct mounting and will not require any damper linkage. Actuators can be mounted directly with a universal clamp to the following:
 - 1) Round damper shaft from 3/8 in. (10 mm) up to 1 in. to 1/16 in. (27 mm)
 - 2) Square damper shaft from 3/8 in. (10 mm) up to 3/4 in. (19 mm)
- g. NSR actuators shall feature an optional NEMA 4X/IP66 weather shield for applications in harsh environments.
- h. NSR actuators shall be furnished such that the actuator complies with the following control signals:
 - 1) The NSR actuators shall be available in models that accept input signal controls for on/off, floating, and proportional control.
 - 2) The NSR actuators shall operate with an automatic signal input detection which allows automatic recognition of input signals for on/off, floating and proportional control. They shall be equipped with adjustable span automatic controls that require no special tools.
 - 3) In proportional mode, the actuator shall respond to control signals DC 0 V to 10 V or DC 2 to 10 V.
 - 4) When a 500-ohm resistor is added in proportional mode, the actuator shall respond to a 0 mA to 20 mA, or 4 mA to 20 mA signal. A feedback signal of DC 0 V to 10 V, or DC to 10 V indicates position.
- i. NSR actuators shall be available in line voltage On/Off and floating models to offer reduced total installation cost by avoiding installation of external power supply adapters.
- j. NSR actuators shall be available in high speed On/Off and floating models for applications in loop that require a quick response time.
- k. NSR actuators shall offer optional auxiliary switches to provide the following:
 - 1) Two line-voltage-capable single-pole, double-throw (SPDT) switches with continuously adjustable switch points

- 2) An auxiliary potentiometer kit provides and potentiometer feedback options for improving safety, interface and signal
- l. NSR actuators shall be furnished with the option of backward compatible to produce a seamless retrofit without the need to replace the controller.
- m. NSR actuators shall have the option to be furnished with a plenum-rated cable which are specially configured for installation in spaces used for environmental air-handling purposes, other than ducts and plenums, as specified in National Fire Protection Association (NFPA) 70: National Electrical Code section 300.22(C), Other Space Used for Environmental Air.
- n. NSR actuators shall have a constant runtime which is independent of supply voltage frequency and load.
- o. NSR actuators for Floating and On/Off models for line voltage (AC 85 to 264 V) for standard speed applications shall operate with AC 85 to 264 V and provide the rated torque. The actuators shall be designed to provide constant runtime, independent of supply voltage frequency and load.
- p. NSR actuators for Floating and On/Off models for AC/DC 24 V for high-speed applications shall have an 8-second constant runtime, independent of supply voltage frequency and load.
- q. NSR actuators shall be furnished with electronic stall detection which protects the actuator from overload at all angles of rotation. The actuator may be stalled anywhere in its rotation range without the need for mechanical end switches.
- r. NSR actuators shall be equipped with microprocessor-controlled brushless DC motors which provides constant runtime independent of torque and increases the actuators lifecycle by reducing water.
- s. NSR Actuators shall have the option of a bottom-mounted coupler which simplifies short shaft damper applications.
- t. NSR actuators shall offer multiple shaft coupling methods:
 - 1) For units above 80 lb-in a toothed V-bolt clamp and nuts with a toothed cradled shall be used
 - 2) For units 80 lb-in. and below use a single-cup-point set screw and toothed cradle shall be used
- u. NSR actuators shall be furnished with a Minimum IP (ingress protection) enclosure ratings as follows:
 - 1) Actuator for types with covered wiring terminals shall be furnished as NEMA type 2/IP42 mounted in any orientation.
 - 2) Actuators for types without a covered wiring terminal shall be furnished with a NEMA type 1/IP30 or IP40.
 - 3) Actuators for types with integrated cables shall be furnished as NEMA type 2/IP42 mounted in any orientation.
 - 4) NSR actuators shall be furnished with a minimum IP (ingress protection) rating of no lower than IP42 but also be available in NEMA5/IP54.
 - 5) NSR actuators shall be able to operable in a temperature range of -4°F to 122°F (-20°C to 50°C) except for VAV and similar indoor applications in which 32°F to 122°F (0°C to 50°C) is acceptable.

- w. NSR actuators shall be provided with the following power requirements:
 - 1) 24 V with models available for both 24 VAC and 24 VDC operation (maximum)
 - 2) For NSR actuators above 80 lb-in. a maximum of 7.5 VA at 24 VAC
 - 3) For NSR actuators 80 lb-in. or below a maximum of 3.5 VA at 24 VAC
- x. NSR actuators shall be sized for the torque required to seal the damper at load conditions. For NSR actuators in parallel operation, actuators shall be available that are capable of being mechanically or electrically paralleled automatically.
- y. NSR proportional actuators shall be user configurable without requiring the use of external computer software or programming tools.
- z. NSR actuators shall also be furnished with the option of backward compatible auxiliary switch kits and auxiliary potentiometers which allow for a seamless retrofit without the needs to replace the controller.

2.6 SENSORS AND TRANSMITTERS

A. General Requirements

- 1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements. Exact OEM equivalents of specified sensors and transmitters shall be acceptable if clearly identified in submittals.

B. Temperature Sensors

1. General Requirements

- a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- b. The temperature sensor shall be of the resistance type and shall be either two-wire 1000-ohm nickel RTD, or two-wire 1000-ohm platinum RTD. Thermistor sensors of 10,000- or 2,250-ohms resistance may be substituted based on the application.
- c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion.

2. Thermowells

- a. Thermowell manufacturer shall have models available in stainless steel, brass body, and copper bulb.
- b. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.
- c. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
- d. Thermowells and sensors shall be mounted in a direct mount (no adapter) offering faster installation or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.

- e. Thermowells constructed of 304 stainless steel shall comply with Canadian Registration Number (CRN) pressure vessel rating.

3. Outside Air Sensors

- a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall be provided with a solar shield.
- b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
- c. Temperature transmitters shall be of NEMA 3R (IP54) or NEMA 4 (IP65) construction and rated for ambient temperatures.
- d. The outdoor sensor shall be capable of being mounted on the side of a building utilizing its preassembled mounting bracket.
- e. Outside air relative humidity sensors 0-100% full range of accurate measurement. Operating temperature -4 to 140°F (-20 to 60°C).
- f. Outside air temperature sensors operating temperature range -40 to 140°F, +/- .55°F (+/- .3°C).

C. Humidity Sensors

- 1. The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.
- 2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA or 0-10 vdc or network, 0-100% linear proportional output.
- 3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH at 77°F (25°C) unless specified elsewhere.
- 4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R (IP54) or NEMA 4 (IP65) enclosure with sealite fittings.
- 5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
- 6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
- 7. Acceptable Manufacturers: Johnson Controls and Vaisala.

D. CO₂ Sensors

- 1. Where shown on the drawings, CO₂ sensors shall have the following features for Analog:
 - a. Jumper selectable: 0-20mA, 4-20mA & 0-10 VDC output
 - b. Liquid Crystal Display (LCD)
- 2. The CO₂ shall transmit the information back to the controller by jumper selectable 0-20mA, 4-20mA & 0-10 VDC output signals and MS/TP:
 - a. The CO₂ sensors shall provide a maximum output current of 25mA; Maximum output voltage of 12.5V.

- b. The CO₂ sensors shall be FCC compliant to CFR47 Part 15 subpart B Class A.
 - 3. Where shown on the drawings, CO₂ sensors shall have the following features for BACnet communicating:
 - a. Dual channel NDR
 - b. Auto Calibrated CO₂ selectable feature
 - 4. The CO₂ sensors shall have the ability to monitor and output the following variables as required by the systems sequence of operations:
 - c. Zone CO₂
 - 5. The CO₂ sensors shall be available with:
 - a. CO₂ measurement accuracy of $\pm(30\text{ppm} + 3\% \text{ of reading})$
 - b. CO₂ non-linearity of less than 1.0% of full scale
 - 6. The CO₂ sensors may include the following items:
 - d. Relay output module
 - e. LCD module
 - f. Analog temperature module with linear 0-10 VDC output for 32-122F
- E. Differential Pressure Transmitters
- 1. General Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - 2. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - 3. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
 - 4. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
 - 5. Low Differential Water Pressure Applications (0" - 20" WC):
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 - 6. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - a. .01-20" WC input differential pressure range

4-20 mA output

Maintain accuracy up to 20 to 1 ratio turndown

Reference Accuracy: +0.2% of full span

7. Acceptable Manufacturer: Setra
8. Medium to High Differential Water Pressure Applications (Over 21" WC):
 - a. The differential pressure transmitter shall meet the low-pressure transmitter specifications with the following exceptions:
 - 1) Differential pressure range 10" WC to 300 PSI
Reference Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability)
9. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
10. Acceptable Manufacturer: Setra
11. Building Differential Air Pressure Applications (-1" to +1" WC):
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
12. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - a. -1.00 to +1.00 WC input differential pressure ranges. (Select range appropriate for system application)
4-20 mA output
Maintain accuracy up to 20 to 1 ratio turndown
Reference Accuracy: +0.2% of full span
Acceptable Manufacturers: Johnson Controls or approved equal
13. Low Differential Air Pressure Applications (0" to 2.5" WC):
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
14. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications.
 - a. - 1.00" to 5.00") WC input differential pressure ranges (select range appropriate for system application)
4-20 mA, 0-5 VDC, 0-10 VDC output
Maintain accuracy up to 20/1 ratio turndown
Reference Accuracy: +0.25%, or 0.5% of full span

15. Acceptable Manufacturers: Johnson Controls and Setra, or Ruskin
16. Medium Differential Air Pressure Applications (5" to 21" WC):
 - b. The pressure transmitter shall be like the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements.
 - 1) Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability
Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 psig.)
Thermal Effects: <+.033 F.S./Deg. F. over 40°F to 100°F (calibrated at 70°F.)
17. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
18. Acceptable manufacturers: Johnson Controls and Ruskin

F. Flow Monitoring

1. Air Flow Monitoring
 - a. Fan Inlet Air Flow Measuring Stations: Electronic, Thermal Dispersion Technology
 - 1) Furnish and install at locations shown on plans or as in accordance with schedules calling for electronic, thermal dispersion fan inlet airflow and temperature measuring stations. Airflow sensors shall be provided that continuously monitor and report the airflow and temperature at each fan inlet location through one or two sensing nodes per fan.
 - 2) Each complete airflow measuring station shall be constructed and assembled in an ISO:9001 certified factory following strict ISO calibration test procedures.
 - 3) Each fan inlet airflow measuring station shall be capable of collecting up to 32 airflow and temperature readings from max 16 fans. Each sensor can be configured as an independent fan or as a single fan in a multiple fan system.
 - 4) Each fan inlet airflow measuring station shall consist of an interface/transmitter to the building automation system together with the required quantity of sensor cable assemblies based on the number of fans to be monitored.
 - I. Configuration, scaling, calibration, and diagnostic functions shall be performed by means of a password protected, cover mounted set of membrane switches on the face of the interface/transmitter. The interface/transmitter shall feature a 16x2 character alphanumeric, backlit LCD screen.

- II. Electronics enclosures shall be rated NEMA-1 (National Electrical Manufacturer's Association) with availability of NEMA-4 for the interface/transmitter when exposed to an outdoor environment.
 - III. The interface/transmitter shall be provided with two individually configurable, field-selectable (4-20mA or 2-10 VDC), analog signals for volume or temperature outputs. Analog outputs to be protected from short circuits with a resettable solid-state fuse. RS-485 network interface connections (BACnet MS/TP, Modbus RTU) shall be included as standard with the interface/transmitter.
 - The RS-485 network communications shall provide the average airflow rate, average temperature, high and/or low airflow alarms, and high and/or low temperature alarms.
 - 5) Each sensor (sensing node) shall consist of a pair of thermistors, one passive and one heated, for measuring ambient temperature and air volume. Each sensor shall have an operating range of 0 to 10,000 FPM (0 to 3048 MPM) with an accuracy of $\pm 2\%$ of reading for velocity measurement and $\pm 0.10^\circ\text{F}$ ($\pm .06^\circ\text{C}$) for temperature measurement.
 - 6) When installed per manufacturer's guidelines, the fan inlet airflow measuring station shall measure with an accuracy of $\pm 3\%$ of actual airflow with field calibration.
 - 7) The sensors shall be cantilever-mounted into the airstream at the fan inlet using a stainless-steel boom arm to position the sensors according to the manufacturer's recommended guidelines. Each sensor assembly shall include a fixed length cable and connector that plugs into its corresponding electronics enclosure (the interface/transmitter or an additional enclosure for a multiple fan system).
 - 8) For installations which require additional electronics enclosure(s) aside from the BAS interface/transmitter due to the number of fans being monitored, these enclosures will be connected using factory supplied, non-proprietary combination cables (Comm/Power) in a Daisy Chain manner; with wiring terminated on phoenix type connector plugs with screw terminal connections.
 - 9) Each airflow measuring station shall be powered by 24 VAC or 24 VDC (+/- 15%) @ max 15VA.
 - 10) Each airflow measuring station shall have an operating temperature range of -20°F to 120°F (-29°C to 49°C) and humidity range of 0 to 99% RH: non-condensing.
 - 11) Acceptable manufacturers: Johnson Controls and Ruskin
2. Single Probe Air Flow Measuring Sensor
- a. The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a thermal dispersion and utilize one temperature sensor and a heated

thermistor. The sensor pair shall measure the air temperature and airflow velocity.

3. Static Pressure Traverse Probe

- a. Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
- b. Acceptable manufacturers: Cleveland Controls

4. Shielded Static Air Probe

- a. Where indicated on plans or in schedules a shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding.

5. Water Flow Monitoring

- a. Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.
- b. Acceptable manufacturers: Onicon

G. Power Monitoring Devices

1. Current Measurement (amps)

- a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

2. Current Transformer – A split core current transformer shall be provided to monitor motor amps.

- a. Operating frequency – 50 - 400 Hz
- b. Insulation – 0.6 Kv class 10Kv BIL
- c. UL recognized
- d. Five amp secondary
- e. Select current range as appropriate for application
- f. Acceptable manufacturers: Setra, Senva, or EIG

3. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

- a. 6X input over amp rating for AC inrushes of up to 120 amps
- b. Manufactured to UL 1244
- c. Accuracy: +.5%, Ripple +1%
- d. Minimum load resistance 30kOhm
- e. Input 0-20 amps
- f. Output 4-20 mA
- g. Transducer shall be powered by a 24 VDC regulated power supply (24 VDC +5%)
- h. Acceptable manufacturers: Setra, Senva, or EIG

H. Status and Safety Switches

1. General Requirements

- a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the Building Management System (BMS) when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches

- a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

3. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

4. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

5. Acceptable manufacturers: Johnson Controls or Setra

6. Water Flow Switches

- a. Water flow switches shall be equal to the Johnson Controls P74.

7. Low Temperature Limit Switches

- a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

8. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturer's recommended installation procedures.

9. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

10. The low temperature limit switch shall be equal to Johnson Controls A70.

I. Control Relays

1. Control Pilot Relays

- a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

2. Mounting Bases shall be snap-mount.

3. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

4. Contacts shall be rated for 10 amps at 120 VAC.

5. Relays shall have an integral indicator light and check button.

6. Acceptable manufacturers: Johnson Controls.

J. Electronic Signal Isolation Transducers

1. A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel) or is to receive as an input signal from a remote system.
2. The signal isolation transducer shall provide ground plane isolation between systems.
3. Signals shall provide optical isolation between systems.
4. Acceptable manufacturers: Advanced Control Technologies

2.7 CONTROL VALVES

A. Ball Valves, 1/2 through 2 in.

1. Ball Valves shall have forged brass bodies.
2. Valves shall have available either Chrome Plated Brass Balls or 300 Series Stainless Steel Balls.
3. Valves shall have available either Nickel Plated Brass Stems or 300 Series Stainless Steel Stems with a blow-out proof stem design.
4. Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.
5. Stem seals shall be double EPDM O-rings.
6. Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psi maximum differential pressure and shall be inserted against the casting of the valve.
7. All ball valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F (95°C) fluid temperature.
8. All ball valves with sweat end connections or press end connection shall be rated to 300 psig maximum static pressure at 203°F (95°C) fluid temperature.
9. All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
10. Ball Valves with stainless steel balls and stems shall be rated for use with 15 psig saturated steam.
11. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
12. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
13. Valves shall be maintenance free.
14. Valves shall be provided with a 5-year equipment warranty.
15. Valves shall be rated for 200 psi differential closeoff pressure.
16. Valve actuators shall be UL-recognized or CSA-certified.
17. Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.

B. Ball Valves, ½ in. to 1 in. with integrated controller

1. Ball valves shall have forged brass bodies.
2. Valves shall be available in chrome plated brass balls.
3. Valves shall be available in all sizes with a nickel-plated brass stems.
4. Valves shall have graphite reinforced PTFE seats with EPDM O-ring backing.

5. Stem seals shall be double EPDM O-rings.
6. Flow characterization disks shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure and shall be inserted against the casting of the valve. The valves shall be installed in any flow direction because of the non-directional disk design.
7. Flow characteristics shall be of equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
8. Valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F (95°C) fluid temperature.
9. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
10. Ball valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% maximum flow, bypass port.
11. Ball valves shall be maintenance free.
12. Ball valves shall be provided with a 5-year warranty from the date of sale. Valves sold in the APAC region shall comply with an 18-month warranty policy.
13. Ball valves shall be rated for 200 psid (1,378 kPa) close off pressure.
14. Ball valves shall be UL-recognized or CSA-certified. APAC valves shall be excluded from this regulatory information.
15. Ball valves shall be Johnson Controls VG1000 Series Ball Valves or approved equal.

C. Ball valves ½ in. through 1 in with integrated controllers and actuators

1. The specifications apply to Ball valves ½ in. through 1 in. with integrated controller or actuators.
2. The actuator or controller shall provide both standalone and networked direct digital control of terminal units.
3. The actuator or controller shall be BACnet Testing Labs (BTL) listed/certified and carry the BTL Label.
4. The actuator or controller shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
5. A BACnet Protocol Implementation Conformance Statement shall be provided for the actuator or controller.
6. The actuator or controller shall communicate over the Field Controller Bus (FC Bus) using BACnet Standard protocol SSPC-135, Clause 9.
7. The actuator or controllers shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
8. The actuator/controller shall be a configurable digital controller. All components shall be connected and mounted as a single assembly that can be removed as one piece.
9. The actuator or controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL95-5VB or the controller is designed and suitable for use in other environmental air spaced (plenums) in accordance with Section 300.252© of the National Electrical Code.
10. Each controller shall continuously and adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. This

- shall reduce commissioning costs and eliminated the maintenance costs of manually re-tuning loops to compensate for load changes.
11. The controller shall provide the ability to download and upload configuration files, both locally and through the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
 12. Control set point changes initiated over the network shall be written to the actuator or the controller's non-volatile memory to prevent the loss of set point changes and to prove consistent operation in the event of a communication failure.
 13. The controller firmware shall be flash-upgradeable remotely through the communications bus to minimize the cost of feature enhancements.
 14. Inputs:
 - b. Analog inputs with user defined ranges shall monitor the following analog signals, with only the equipment in the terminal controller cabinet:
 - 1) 0 VDC to 10 VDC Sensors
 - 2) 1000-ohm RTDs
 - 3) NTC Thermistors
 14. Binary inputs shall monitor dry contact closures. Filtering shall eliminate false signals resulting from input 'bouncing'.
 15. The inputs shall be isolated from power, communications, and output circuits for noise immunity.
 16. Provide side loop application for humidity control.
 17. Outputs:
 - a. Analog output shall provide a 0 VDC to 10 VDC control output.
 19. Binary outputs shall provide a SPST Triac output rated for 500 mA at 24 VAC.
 20. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
 21. The actuator or controller shall be configured with a software tool that provides a question-and-answer format for developing and downloading applications.
 22. Sensor support:
 - a. The actuator or controller shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
 23. The actuator or controller shall support an LCD display room sensor.
 24. The actuator or controllers shall support standard room sensors as defined by analog input requirements.
 25. The actuator or controllers shall support humidity sensors defined by the AI side loop.

D. Ball Valves, 2 1/2 in. through 6 in. flanged

1. Ball valves shall have forged brass bodies with ASME Class 150 ductile iron flanges.
2. Valves shall be manufactured from 300 series stainless steel balls and the flanges shall rotate independently until tightened down which is an advantage during installation.
3. Valves shall have 300 series steel stems with a blow-out proof stem design.
4. Stem seals shall have double EPDM O-rings.

5. Valves have graphite reinforced PTFE seats with EPDM O-ring backing.
 6. Flow characterization disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure.
 7. Flow characteristics shall be of equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
 8. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions and are rated for use with 25 psig (kPa) saturated steam.
 9. Two-way valves shall be rated for 100 psid close off pressure and three-way valves shall be rated for maximum of 50 psid close off pressure.
 10. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
 11. Valves shall be maintenance free.
 12. Valves shall be provided with a 5-year warranty. Valves sold in the APAC region shall comply with an 18-month warranty policy.
 13. Valves shall be CE marked as Johnson Controls declares these valves are in compliance with essential requirements and other relevant provisions of the Pressure Equipment Directive (PED). APAC actuators shall be excluded from this regulatory information.
 14. Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.
- E. Butterfly Valves, High Performance 8 through 16 in.
1. Butterfly valve shall have bodies manufactured from carbon steel, ASTM A216 GR WCB/A516 GR 70 and shall be fully lugged per ASME Class 150 or ASME Class 300.
 2. Valve seat assemblies shall be RPTFE (reinforced polytetrafluorethylene) and the seat retainer shall be carbon steel, ASTM A516 GR 70.
 3. Valve disks shall be stainless steel, ASTM A 351 GR CF8M.
 4. Valve stems shall be 17-4 PH stainless steel, ASTM A564-Type 630.
 5. Stem seals shall be one carbon fiber ring and three TFE rings.
 6. Flow characteristics shall be equal percentage up to 70° of disk rotation.
 7. Valves shall be rated for service with hot water, chilled water, 50% glycol solutions and 50 psig (kPa) saturated steam in modulating service or 150 psig (kPa) saturated steam in two position service.
 8. Valves shall meet the performance requirements of the ASME Class 150 and Class 300.
 9. Valves shall be maintenance free.
 10. Valves shall be provided with a 3-year warranty. Valves sold in the APAC region shall comply with an 18-month warranty policy.
 11. Valves shall be UL-recognized or CSA-certified. APAC valves shall be excluded from this regulatory information.
 12. Valves shall be Johnson Controls VF Series Butterfly Valves or approved equal.
- F. Valves Electric Zone Valves, 1/2 through 1-1/4 in.
1. Electric zone valves shall have bodies manufactured from forged brass.
 2. Valve stems shall be manufactured from hard chrome plated brass.
 3. Modulating valves flow characteristics shall be of equal percentage.

4. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
5. Two position valves shall have models available rated for use with 15 psig saturated steam.
6. Valves shall be replaceable without being removed from the pipe.
7. Valves are provided with a 2-year warranty. Valves sold in the APAC region comply shall with an 18-month warranty policy.
8. Valves shall be UL, cUL listed or CSA certified. APAC valves shall be excluded from this regulatory information.
9. Valves shall be Johnson Controls J Series electric zone valves or an approved equal.

2.8 DDC EQUIPMENT CONTROLLERS

A. General Purpose Equipment Controller (CGE controllers)

1. The General Purpose Equipment Controller shall be a fully programmable, digital controller. The CGE controller communicates by the BACnet/IP protocol or BACnet/SC protocol.
 - a. The CGE shall support BACnet Standard ANSI/ASHRAE 135.
 - 1) The CGE shall be BTL listed/certified.
 - 2) The CGE shall be tested and certified as a BACnet Advanced Application Controller (B-AAC) and shall conform with BACnet Protocol Revision 18 or higher.
 - 3) A BACnet Protocol Implementation Conformance Statement shall be provided for the CGE.
 - 4) The Conformance Statement shall be submitted 10 days prior to bidding.
 - c. The CGE shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
 - d. CGE controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
 - e. The CGE shall be assembled in a plastic housing with protection class IP20 (IEC529) and flammability rated to UL94-5VB.
 - f. The CGE shall include an integral real-time clock and support time-based tasks which enables these equipment controllers to monitor and control:
 - 1) Schedules
 - 2) Calendars
 - 3) Alarms
 - 4) Trends
 - g. The CGE can continue time-based monitoring when offline for extended periods of time from a network.

- h. The CGE can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment controllers.
- i. The CGE shall include troubleshooting LEDs to indicate the following conditions:
 - 1) Power – to indicate if the controller is powered or not powered
 - 2) Fault – to indicate if the controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
 - 3) SA Bus – to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
 - 4) ETH-1 – to indicate if the controller is connected and communicating, or is not connected
 - 5) ETH-2 – to indicate if the controller is connected and communicating, or is not connected
- j. The /CGE shall have the ability to transfer and apply firmware files to all SA Bus devices (XPM, IOM, and NS8000) connected to it.
- k. The CGE shall include pluggable screw terminal blocks for all I/O, SA Bus communication, and power wiring connections. The CGM also includes a pluggable screw terminal block for FC bus communication.
- l. The CGE shall accommodate the direct wiring of analog and binary I/O field points with the following resolution.

B. Inputs – 24-bit analog-to-digital converter

- 1. Outputs – +/- 200 mV accuracy in 0-10 VDC applications
 - a. The CGE shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:
 - 1) Universal Inputs – shall be configurable to monitor any of the following:
 - a) 0-10 VDC analog input
 - b) 4-20 mA analog input
 - c) 0-600k ohms analog input
 - d) Dry contact binary input
 - 2) Binary Inputs – shall be configurable to monitor either of the following:
 - a) Dry Contact Maintained Mode
 - b) Pulse Counter Mode
 - 3) Analog Outputs – shall be configurable to output either of the following:
 - a) 0-10 VDC analog output
 - b) 4-20 mA analog output

- 4) Binary Outputs – shall output the following:
 - a) 24 VAC Triac
 - 5) Configurable Outputs – shall be capable of the following:
 - a) 0-10 VDC analog output
 - b) 24 VAC Triac binary output
- C. The CGE shall have the ability to reside on the Automation Network with the following capabilities:
1. The ability to communicate with Open Data Servers (BACnet listed OWS) and Network Engines.
 2. Support for BACnet IPv4.
 3. Support for Peer-to-Peer communications with other controllers on the automation network.
- D. The CGE shall be FIPS 140-2 Level 1 compliant. FIPS 140-2 is a U.S. government cyber security standard used to approve cryptographic modules and algorithms used for encryption.
- E. The CGE shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.
1. The SA Bus shall support a minimum of 10 devices per trunk.
 2. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the CGE and the furthest connected device.
- F. The CGE shall support, but not be limited to, the following applications.
1. Chilled water/central plant optimization applications including but not limited to:
 - a. Selection and sequencing of up to eight chillers of different sizes.
 - b. Selection and sequencing of up to eight (each) primary and secondary chilled water pumps of varying pumping capacities.
 - c. Selection and sequencing of up to eight condenser water pumps.
 - d. Selection and sequencing of cooling towers and bypass valve, including single speed, multi-speed, and Vernier control.
 - e. Selection and sequencing of up to four heat exchangers of different capacities.
 - f. A proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, to meet the building load using the least amount of energy as calculated.
 - g. The use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, to determine equipment, start and runtime preferences.
 - h. Identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant.

- i. Control definition for the chiller plant in a single CGM, CGE, FEC, or Network Control Engine, as supported by available memory and point I/O, or capable of being split across multiple CGMs, CGEs, FECs, or Network Control Engines.
 - 1) Heating central plant applications.
 - 2) Built-up air handling units for special applications.
 - 3) Terminal & package units.
 - 4) Special programs as required for systems control.
- G. The CGE shall support a Local Controller Display as a remote device communicating over the SA Bus.
 - 1. The Display shall use a BACnet IP
 - 2. The Display shall allow the user to view monitored points without logging into the system.
 - 3. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
 - 4. The Display shall provide password protection with user adjustable password timeout.
 - 5. The Display shall be menu driven with separate paths for:
 - a. Input/Output
 - b. Parameter/Setpoint
 - c. Overrides
 - 1) The Display shall use easy-to-read English textual messages.
 - 2) The Display shall be configurable by allowing the user to select the points to be shown, as well as the order and groupings of the points.
 - 3) The display shall provide the ability to viewpoints in alarm locally at the controller.
 - 4) The display shall provide the ability to view trends defined for the points locally in the controller.
 - 5) The Display shall support a color display screen the ability to set the brightness of screen that is used during user interaction and an adjustable backlight timeout to control how long the display remains backlit when there is no user interaction.
 - 6) The display shall allow the user to set the date and time format that is shown in the display.
 - 7) The display shall be a minimum of 3.5-inch screen with 320x240 resolution.
 - 8) The Display shall have a navigation keypad with no more than 7 tactile keys.
 - 9) The Display shall be panel mountable.
- H. Provide Johnson Controls CGE or approved equal as shown on plans (BACnet IP only).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

3.2 INSTALLATION

- A. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.
- B. Unless otherwise noted, install wall mounted thermostats and humidistat 48" above the floor measured to the center line of the instrument, or as otherwise directed by the Architect.
- C. Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.
- D. Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.
- E. Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.
- F. Furnish automatic dampers to mechanical contractor for installation.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. BAS contractor shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be provided in accordance with all local and national codes and as described below:
 - 1. All wiring associated with the installation will be the responsibility of this Contractor, unless otherwise directed herein. The term "wiring" is construed to include furnishing of wire, conduit, miscellaneous material and labor as required, to install a total working system.
 - 2. All low voltage (30V and below) wiring above accessible, concealed and dry locations may be run in plenum-rated cable without conduit (must be independently supported every 5 feet with bridle rings or other method approved by the consulting engineer). All low voltage wiring in mechanical spaces or electric/telephone closets must be run in electric metallic tubing (EMT), 3/4-inch or greater. All indoor wiring 30vac or greater shall be run in EMT conduit. All outdoor wiring shall be run in rigid metallic conduit. Seal tight may be used within 6 feet of the final connection to the device or panel.
 - 3. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor.
 - 4. Wiring for controls furnished by others:
 - a. Provide control wiring for HVAC controls furnished by others. Wiring may include, but not limited to, the following items:
 - 1) Thermostats
 - 2) Chiller control devices shipped loose
 - 3) Emergency Shutdown Switches not shown on electrical drawings

3.4 START-UP AND COMMISSIONING

- A. When installation of the system is complete, calibrate equipment and verify transmission media before system is placed on-line. All testing, calibrating, adjusting, and final field tests shall be completed by the BAS contractor. The BAS contractor shall return during off season to verify seasonal functions are working properly.
- B. Perform a two-phase commissioning procedure consisting of field I/O calibration and overall system sequence of operation commissioning. Document that each point was verified and operating correctly on commissioning sheets, which shall be submitted prior to acceptance testing. The commissioning must be coordinated with the owner to ensure systems are available when needed.

3.5 PROJECT RECORD DOCUMENTS

- A. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
 - 1. Complete as-built installation drawings for each building system.
 - 2. Parts list with manufacturer's catalog numbers and ordering information.
 - 3. Manufacturer's catalog literature for each piece of equipment.
 - 4. Sequence of operation for automatic and manual operating modes for all building systems.
 - 5. Redline mechanical drawings indicating all communication truck paths and all remotely installed devices including pump differential pressure sensors, etc.

3.6 TRAINING

- A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. The training shall occur once the system is 100% operational and fully tested by the BAS contractor/manufacturer. Operator instruction during normal working hours shall be performed by a controls manufacturer (JCI) representative familiar with the Building Automation System's software, hardware and accessories.
- B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 32 hours of onsite training on the operation of all BAS equipment. The redline mechanical drawing indicating system components locations must be available prior to training session. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:
 - 1. Explanation of drawings and operator's maintenance manuals.
 - 2. Walk-through of the job to locate all control components.
 - 3. DDC Controller operation/sequence.
 - 4. Operator control functions including scheduling, alarming, and trending.
 - 5. Explanation of adjustment, calibration and replacement procedures.

END OF SECTION 230923

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SECTION 230993 - HVAC CONTROL SEQUENCE

PART 1 - GENERAL:

1.1 DESCRIPTION OF THE WORK:

- A. A new control system shall be integrated with the building's existing control system.
- B. Software for the existing system shall be upgraded to the latest version as part of this work so that the new controls can be integrated into the existing system.
- C. Provide new graphics for the new equipment and integrate with the existing graphics.
- D. Control Sequence is hereby defined to mean the manner in which, and methods by which, the automatic temperature controls function. The requirements for each type of operation are specified in this section.
- E. The operation equipment, devices and system components required for the automatic temperature control system are specified in Section 230900 of these specifications.

1.2 SUBMITTALS:

- A. General: Submittals on temperature control work are required for shop drawings, manufacturer's data, operating instructions, maintenance manuals, wiring diagrams and the system guarantee and product warranties.

1.3 PHASING:

- A. The work shall be undertaken in a manner to accomplish the work in phases as shown on the phasing drawings and descriptions.
- B. The existing heating and cooling systems must remain active until all phases are complete or are fully operable by the new system.
- C. Existing controls must remain active during the construction as long as existing equipment is still being utilized.
- D. At the conclusion of each phase, the new BAS system shall be updated with the new points and system graphics.

1.4 GENERAL:

- A. All controls shall be provided to meet the sequence of operations.

- B. All safety devices shall be hardwired to the starter and shall have a second contact for monitoring via the BAS.
- C. All points required by the sequence of operation including, but not limited to, the points listed in the sequences of operation below, as well as all of the points' associated values, shall be connected to the BMS and available to the BMS operators on all operator workstations and all operator interface devices as part of a graphical display that depicts the mechanical system controlled.
- D. All dampers, controllers, control devices, etc. exposed to outside air conditions shall be specifically designed for outside air conditions including, but not limited to, NEMA 4X enclosures, weatherproof enclosures and all other weather precautions recommended by the manufacturer.

PART 2 - CONTROLS

2.1 DAY-NIGHT INDEXING:

- A. A direct digital controller shall provide the automatic signals for occupied or unoccupied control. For each zone listed below, provide a software graphical user interface that allows authorized maintenance personnel to select or override the automatic signals for occupied or unoccupied control on the Building Automation System (BAS) user interface. An alarm shall be generated on the BAS when the Zone is selected as "Override". Provide a separate zone for each area of the building as divided on the partial floor plans. Zone names to be coordinated with the Owner and Engineer.
- B. Whenever any zone is indexed to occupied cycle, the unit or units shall run continuously and shall be controlled as specified hereinafter. When indexed to the unoccupied cycle, the room sensors shall be reset to night temperature and shall cycle their respective units to maintain the setback or setup setpoints. In addition, whenever a classroom zone is indexed to the occupied cycle, the toilet exhaust fans shall operate. The toilet exhaust fans shall be off during the unoccupied cycle.

2.2 OCCUPIED-UNOCCUPIED CYCLES:

- A. When any zone is indexed to the night cycle, all air handling units within the zone shall stop, all thermostats shall be indexed to their night setting and shall control their respective units to cycle the unit to maintain a reduced space temperature. During this cycle all associated exhaust fans shall be stopped and all associated outdoor and relief dampers shall be closed. When indexed to the occupied cycle, the units shall run continuously and shall be controlled as specified hereinafter. The automatic occupied - unoccupied signals shall incorporate an adaptive optimum start algorithm that shall utilize both the zone temperature and the outside air temperature to start the mechanical equipment so as to reach occupied temperature targets just in time for occupancy.

2.3 WARM-UP OR COOL-DOWN CYCLE:

- A. For all air handlers, provide the necessary devices required to keep the outside air dampers closed during the warm-up and cool-down cycles prior to occupancy as determined by the optimum start algorithm.

2.4 MULTIPLE ZONE VAV ROOFTOP UNIT: RTU-1

- A. Units are equipped with supply air fan, outside air/return air dampers, exhaust fan, airflow monitoring station, DX cooling coils, hot gas reheat coil, compressors and condensing fans.
- B. Units shall be equipped with a factory provided controller with built-in sequences of operation. The controller shall be capable of the following modes of operation:
 - 1. Occupied/Unoccupied Mode
 - 2. Warm-Up/Cool-Down Mode
 - 3. Cooling Mode
 - 4. Heating Mode – Duct mounted Hot water coil
 - 5. Economizer Mode via Comparative Enthalpy
 - 6. Dehumidification Mode via Hot Gas Reheat
- C. Manufacturer provided duct static pressure sensor shall be field installed in the ductwork and wired back to RTU controller.
- D. Duct mounted hot water coil controls shall be wired to RTU controller. The discharge air sensor shall be field installed downstream of hot water coil. Provide condensate drain pan sensor and generate an alarm to BAS, if moisture detected. Provide freeze
- E. The Building Automation System (BAS) shall interface with the controller so that all available points (including alarms) are on the BAS. The following points shall be displayed on the BAS: outside airflow, return air temperature/humidity, outside/return damper positions, filter status, mixed air temperature/humidity, compressor status, hot gas reheat status, supply & exhaust fan status and speed, supply air temperature/humidity, space temperature/humidity/carbon dioxide level and alarms.
- F. BAS shall command unit to the occupied, unoccupied, warmup, and cool-down modes and command the discharge air temperature setpoint.
- G. Discharge Air Temperature Reset Control:
 - 1. At a frequency of once every 10 minutes, the BAS shall monitor the outdoor dry-bulb temperature, as well as the zone temperature and damper position of all VAV terminal units.
 - 2. The BAS shall calculate a new SAT set-point based on current outdoor air (OA) temperature, and send this newly-calculated SAT setpoint to the AHU controller.
 - 3. When the OA temperature is warmer than 65°F (adj), the SAT set-point shall be 55°F (adj).
 - 4. When the OA temperature is colder than 55°F (adj), the SAT set-point shall be 65°F (adj).

5. When the OA temperature is between 55°F (adj) and 65°F (adj), the SAT set-point shall be reset proportionally between 55°F (adj) and 65°F (adj).
 6. If at least two (adj) zones have both 1) a VAV damper that is more than 75% open, and 2) a current zone temperature that is higher than the current cooling set-point, then the SAT set-point shall return to 55°F (adj).
 7. If the outdoor dew point is higher than 60°F (adj), this SAT Reset sequence shall be suspended and the SAT set-point shall be reset to 55°F (adj) until outdoor dew point drops below 57°F (adj).
- H. Safeties: For units with capacity greater than or equal to 2000 CFM, duct smoke detector(s) shall be provided. Power wiring to duct detector(s) shall be provided by the Electrical Contractor and control shutdown wiring shall be provided by this contractor. Upon sensing the products of combustion, the fan shall be de-energized, the outside air damper shall be closed, the heating and cooling shall be off and an alarm message shall be generated on the Building Automation System.
- I. Provide a freezestat temperature low limit with 20' serpentine element responsive to the coldest 1' length in the inlet of the heating coil wired to the unit DDC controller. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the recirculation damper, open the unit heating coil control valve, and generate an alarm on the BAS.

2.5 SINGLE ZONE VAV ROOFTOP UNIT: RTU-2 & 3

- A. Units are equipped with supply air fan, outside air/return air dampers, relief fan, airflow monitoring stations, DX cooling coils, hot gas reheat coils, compressors and condensing fans.
- B. Units shall be equipped with a factory provided controller with built-in sequences of operation. The controller shall be capable of the following modes of operation:
1. Occupied/Unoccupied Mode
 2. Warm-Up/Cool-Down Mode
 3. Cooling Mode
 4. Heating Mode – Duct mounted Hot water coil
 5. Economizer Mode via Comparative Enthalpy
 6. Dehumidification Mode via Hot Gas Reheat
- C. Manufacturer provided thermostat shall be field installed and wired back to RTU controller.
- D. Duct mounted hot water coil controls shall be wired to RTU controller. The discharge air sensor shall be field installed downstream of hot water coil. Provide condensate drain pan sensor and generate an alarm to BAS, if moisture detected.
- E. The Building Automation System (BAS) shall interface with the controller so that all available points (including alarms) are on the BAS. The following points shall be displayed on the BAS: outside airflow, return air temperature/humidity, outside/return damper positions, filter status, mixed air temperature/humidity, compressor status, hot

gas reheat status, supply fan status and speed, supply air temperature/humidity, space temperature/humidity/carbon dioxide level and alarms.

- F. BAS shall command unit to the occupied, unoccupied, warmup, and cool-down modes and command the space temperature setpoint.
- G. Safeties: For units with capacity greater than or equal to 2000 CFM, duct smoke detector(s) shall be provided. Power wiring to duct detector(s) shall be provided by the Electrical Contractor and control shutdown wiring shall be provided by this contractor. Upon sensing the products of combustion, the fan shall be de-energized, the outside air damper shall be closed, the heating and cooling shall be off and an alarm message shall be generated on the Building Automation System.
- H. Provide a freeze/temperature low limit with 20' serpentine element responsive to the coldest 1' length in the inlet of the heating coil wired to the unit DDC controller. Upon sensing a temperature below 38 degF., the device will trip to de-energize the supply air fan, close the outside air dampers, open the recirculation damper, open the unit heating coil control valve, and generate an alarm on the BAS.

2.6 SHUTOFF VAV BOX CONTROL:

- A. Supply controls to the VAV box manufacturer for factory installation.
- B. The VAV box is to be controlled independent of system pressure fluctuations by an application specific DDC controller using electric actuation. The space served by the VAV box is controlled in Occupied and Unoccupied as indexed by the BAS according to its respective zone signal.
- C. During the unoccupied cycle the VAV box primary air damper shall be allowed to be fully closed. VAV box shall open for heating and close on a temperature rise if the AHU is in the unoccupied heating mode. If the unit is in the unoccupied cooling mode, the VAV box damper shall modulate as in occupied cooling mode at a setup temperature setting, but with a zero minimum flow rate.
- D. During the Occupied cycle, the VAV box primary air damper is controlled within user defined occupied maximum and minimum supply air volume settings. The controller monitors the room temperature sensor and air velocity sensor and modulates the primary supply air damper in sequence with the hot water reheat coil control valve to maintain the room temperature at set-point. While the reheat coil is being utilized for heating, the box primary supply damper shall remain at the minimum design CFM as scheduled on the drawings. When the boilers are not in operation, the air flow minimum setting shall be zero or as selected on the BAS and reheat shall not be used.
- E. Room Sensors:
 - 1. The room combination temperature and humidity sensor shall have a concealed set-point adjustment knob with software definable adjustment range (e.g. +/- 2 deg F).

2. All sensor inputs and actuator outputs from the controller shall be available throughout the BAS.

2.7 EXHAUST FAN CONTROL:

- A. Those exhaust fans noted "ATC" on the Exhaust Fan schedule shall run during occupied cycle and remain off during unoccupied cycle of their respective zone. The exhaust fans shall be controlled via spare binary outputs of local DDC controllers such that they can be overridden on/off through the Facility Management System.
- B. Those exhaust fans noted "T-STAT" on the schedule shall be controlled based upon a space temperature sensor via the DDC system. Upon a rise in space temperature, the exhaust fan shall run and any associated intake or exhaust dampers shall open (where applicable). On a fall in space temperature, the reverse shall occur.
- C. Those exhaust fans noted "Switch" on the schedule shall be controlled based upon a status signal from the DDC system. When a switch is engaged the fan shall energize. When the switch is turned off, the fan shall de-energize. All fans controlled by a switch shall de-energize after running for a time period defined by the DDC system.

2.8 CABINET UNIT HEATER CONTROL:

- A. Provide a space temperature sensor for control of each cabinet unit heater. The sensor shall be controlled through the BAS and be indexed to day or night cycle based upon its respective zone signal. Any time that hot water is available as indicated by a global status point, the sensor shall cycle the cabinet heater fan to maintain the day or night temperature set-point. Any time that the unit fan is energized, the modulating hot water control valve shall open.
- B. The cabinet heaters serving vestibules shall be programmed to shut off, when the outside air temperature is greater than 45°F(adj.). The heating setpoint for these spaces shall be limited to 60°F(adj.).

2.9 UNIT HEATER CONTROL:

- A. Provide a space temperature sensor for control of each unit heater. The sensor shall be controlled through the BAS and be indexed to day or night cycle based upon its respective zone signal. Any time that hot water is available as indicated by a global status point, the sensor shall cycle the heater fan to maintain the day or night temperature set-point. Any time that the unit fan is energized, the modulating hot water control valve shall open.

2.10 HOT WATER PUMP PAIRS:

- A. Upon lead pump failure as sensed by the sensor for pump status, and after an adjustable time delay, the lag pump shall be energized. An alarm message shall be generated on the BAS. Pump commands, lead pump selection and flow statuses shall

be available throughout the network. Lead/lag selection shall be alternated by the Building Automation System on a weekly basis.

- B. When there is demand for heating, the heating plant shall be enabled (if disabled). The lead hot water pump shall energize and operate continuously. The BAS shall modulate the speed of the lead pump to maintain the differential pressure setpoint as determined during balancing. Differential pressure shall be monitored at two (2) different locations using new differential pressure sensors. The pumps shall be controlled to the most critical point.

2.11 VARIABLE FREQUENCY DRIVES:

- A. Monitor status of drive for HOA position and drive output.
- B. Provide alarm if drive is in the hand position.
- C. All available points from the VFD shall be displayed on the BAS via BACnet IP.

2.12 TRENDING:

- A. Provide binary points by COS and analog points every 20 minutes with 1 day being stored locally in the head end. This data shall be sent to the server for permanent storage. Coordinate scope with owner.

2.13 SITE LIGHTING CONTROLS:

- A. Provide rib relay across timer and lights to interface site lighting to BAS system. Coordinate exact quantities and work with Electrical Contractor.

2.14 ALARMING:

- A. Any alarm that the Owner defines as critical shall initiate an alarm to the remote Operator Workstation and shall generate an alarm message there. Utilize the District's Ethernet communications and data system. Coordinate scope with owner.

PART 3 - EXECUTION:

3.1 INSTALLATION:

- A. Comply with the manufacturer's recommendations.
- B. All wiring shall be in accordance with the National Electrical Code.

3.2 TEST-ADJUST-BALANCE (TAB) COORDINATION AND ASSIST:

- A. Include all labor for coordination and assistance to the TAB contractor for final system testing, adjusting and balancing.

END OF SECTION 230993

SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Equipment drains and overflows.
- D. Pipe hangers and supports.
- E. Unions, flanges, mechanical couplings, and dielectric connections.
- F. Valves:
 - 1. Gate valves.
 - 2. Ball valves.
 - 3. Butterfly valves.
 - 4. Check valves.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping
- B. Section 08 3100 - Access Doors and Panels
- C. Section 09 9000 - Painting and Coating
- D. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping
- E. Section 23 0554 – Mechanical Identification
- F. Section 23 0719 - HVAC Piping Insulation
- G. Section 23 2114 - Hydronic Specialties
- H. Section 23 2500 - HVAC Water Treatment

1.3 REFERENCE STANDARDS

- A. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers; 2010.

- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; The American Society of Mechanical Engineers; 2011.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2012 (ANSI B16.18).
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; 2001 (R2010).
- E. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2010.
- F. ASME B31.9 - Building Services Piping; 2011 (ANSI/ASME B31.9).
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2011a.
- I. ASTM A312/A 312M; - Standard specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipe 2006.
- J. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984 (Reapproved 2009).
- K. ASTM B32 - Standard Specification for Solder Metal; 2008.
- L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2009.
- M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2005 (Reapproved 2011).
- N. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2012.
- O. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2012.
- P. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2009.
- Q. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2006.
- R. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2006.

- S. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings; 1996 (Reapproved 2010).
- T. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- U. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007.
- V. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2010.
- W. AWWA C606 - Grooved and Shouldered Joints; 2011 (ANSI/AWWA C606).
- X. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Welders Certificate: Include welders' certification of compliance with ASME (BPV IX).
 - 1. Provide weld test results.
- C. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalogue information.
 - 3. Indicate valve data and ratings.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Project Record Documents: Record actual locations of valves.
- F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 - Product Requirements, for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.
 - 3. 1 spare valve handle for each type valve.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.
- C. Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- D. Welder Qualifications: Certify in accordance with ASME (BPV IX).
 - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves. Coating shall be as recommended and supplied by the valve manufacturer.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary plugs, completing sections of the work, and isolating parts of completed system. Temporarily cap or plug incomplete piping sections at the end of each day.

PART 2 PRODUCTS

2.1 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise. Indicate all drawings and supports on the coordination drawings.

C. Valves: Provide valves where indicated:

1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
2. On discharge of condenser water pumps, use spring loaded check valves.
3. Isolate equipment using butterfly valves with lug end flanges mechanical couplings.

D. Welding Materials and Procedures: Conform to ASME (BPV IX).

2.2 HEATING WATER PIPING

A. Steel Pipe: ASTM A 53/A 53M, Schedule 40, black.

1. Fittings: ASTM B 16.3, malleable iron or ASTM A 234/A 234M, wrought steel welding type fittings.
2. Joints: Threaded 2" and under, or AWS D1.1 welded.

B. Copper Tube: ASTM B 88 (ASTM B 88M), Type L, up to and including 2" pipe size.

1. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
2. Joints: Solder, lead free, 95-5 tin-antimony, or tin and silver.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.

1. Fittings: ASTM D2466 or D2467, PVC.
2. Joints: Solvent welded in accordance with ASTM D2855.
3. Do not use PVC in air plenums.

2.4 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with Section 23 2117.

2.5 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Under:

1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.
3. Stainless Steel Pipe: 300 psig (2065 kPa) threaded type

B. Flanges for Pipe Over 2 Inches:

1. Ferrous Piping: 150 psig forged steel, slip-on.

C. Dielectric Connections:

1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600 volt breakdown test.
 - c. Construct of galvanized steel with threaded end, cast bronze with solder joint end, connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.

2.6 GATE VALVES

A. Manufacturers:

1. Conbraco Industries: www.conbraco.com.
2. Milwaukee Valve Company: www.milwaukeevalve.com.
3. Nibco, Inc: www.nibco.com.
4. Tyco Flow Control: www.tycoflowcontrol.com.

B. Over 2 Inches:

1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

2.7 BALL VALVES

A. Manufacturers:

1. Conbraco Industries: www.conbraco.com.
2. Grinnell Mechanical Products, a Tyco International Co: www.grinnell.com.
3. Milwaukee Valve Company: www.milwaukeevalve.com.
4. Nibco, Inc: www.nibco.com.
5. Tyco Flow Control: www.tycoflowcontrol.com.

B. Up To and Including 2 Inches:

1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union. Extended insulated handle for use with insulated piping.

2.8 HIGH PERFORMANCE BUTTERFLY VALVES

A. Manufacturers:

1. Crane Co.: www.cranevalve.com.
2. Grinnell Mechanical Products, a Tyco International Co: www.grinnell.com.
3. Hammond Valve: www.hammondvalve.com.
4. Milwaukee Valve Company: www.milwaukeevalve.com.
5. Tyco Flow Control: www.tycoflowcontrol.com.

B. Body: Carbon steel with Stainless Garter Spring seat, stainless backed RTFE bearing, lug extended insulated neck for use with insulated piping.

C. Disc: CF8M 316 Stainless Steel

D. Stem: Stainless steel blow-out proof stem with offset from the centerline to provide full 360 degree circumferential setting.

E. Operator: Infinite position lever handle with memory stop or gear operator. Provide gear operator for valves 6" size and larger.

2.9 SWING CHECK VALVES

A. Manufacturers:

1. Grinnell Mechanical Products, a Tyco International Co: www.grinnell.com.
2. Hammond Valve: www.hammondvalve.com.
3. Milwaukee Valve Company: www.milwaukeevalve.com.
4. Nibco, Inc: www.nibco.com.
5. Tyco Flow Control; Model Series 712: www.tycoflowcontrol.com.

B. Up To and Including 2 Inches:

1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.

C. Over 2 Inches:

1. Iron body, bronze trim, stainless steel swing disc, renewable disc and seat, flanged ends.

2.10 SPRING LOADED CHECK VALVES

A. Manufacturers:

1. Crane Co.: www.cranevalve.com.
2. Hammond Valve: www.hammondvalve.com.
3. Milwaukee Valve Company: www.milwaukeevalve.com.
4. Tyco Flow Control: www.tycoflowcontrol.com.

- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

2.11 WAFER CHECK VALVES

- A. General: Provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between 2 standard Class 125 flanges. Construct iron body valves with pressure containing parts of materials conforming to ANSI/ASTM A-126, Grade B. Support hanger pins on both ends by removable side plugs.
- B. For Water Service:
 - 1. 2" and Larger: Class 125, cast-iron body, stainless steel trim, bronze disc, Buna-N seal.
- C. Manufacturer: Subject to compliance with requirements, provide ball valves of one of the following:
 - 1. Conbraco
 - 2. NIBCO, Inc.
 - 3. Stockham Valves and Fittings, Inc.

2.12 CALIBRATED BALANCING VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bell & /Gossett Model CS Plus.
 - 2. Armstrong Pump Model CVB.
 - 3. Flow Design Inc. Model UA.
 - 4. Flo Pac Model MB/MBF/MBG
 - 5. Nutech.
- B. Valves 1/2" to 2": to have venture type bronze body, chrome plated ball, EPDM seals. Provide pressure and temperature test ports across valve measurement area. Ports to be fitted with dual durometer EPDM cores, brass cap and O-ring seal. Valves to have drain/purge port. Provide valve with memory stop, memory lock and calibrated position indicator. Valves to be rated at 200 PSIG at 2500 F and be 100% positive shut-off. Measurement accuracy to be +/-3%.
- C. Valves 2-1/2" and Larger: to have venture type cast carbon steel/ductile iron body, with SS stem, EPDM seat and Buna seals. Provide memory stop, memory lock and calibrated position indicator. Valves to be rated at 200 PSIG at 225 F. and be 100% positive shut-off. Measurement accuracy to be +/-3%.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Prepare piping connections to equipment using jointing system specified.
- C. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- D. After completion, fill, clean, and treat systems. Refer to Section 23 2500 for additional requirements.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water to ASME B31.9 requirements. Install chilled water piping to ASME B31.5 requirements.
- C. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- D. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- E. Install piping to conserve building space and to avoid interfere with use of space.
- F. Group piping whenever practical at common elevations.
- G. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 0501 and details.
- H. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- I. Slope piping and arrange to drain at low points.
- J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 0516.
- K. Pipe Hangers and Supports:
 - 1. Refer to Section 23 2117.
 - 2. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-89.
 - 3. Support horizontal piping as scheduled.
 - 4. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

5. Place hangers within 12 inches of each horizontal elbow.
 6. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 7. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 8. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 9. Provide copper plated hangers and supports for copper piping.
 10. Prime coat all steel hangers and supports. Refer to Section 09 9000.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 0719.
- M. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.
- N. Use eccentric reducers to maintain top of pipe level.
- O. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- P. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 9000.
- Q. Install valves with stems upright or horizontal, not inverted.

3.3 INSPECTION:

- A. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings if any. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

3.4 PIPING TESTS:

- A. General: Provide temporary equipment for testing, including pumps and gages. Test piping system before insulation is installed wherever feasible and remove control devices before testing.
- B. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
- C. Required test period is 2 hours.
- D. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
- E. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.
- F. Repair piping systems sections which fail the required piping tests by disassembly and reinstallation, using new materials to the extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.

3.5 VALVE INSTALLATION:

- A. General: Except as otherwise indicated, comply with the following requirements:
 - 1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
 - 2. Install valves with stems pointed up, in the vertical position, where possible, but in no case with stems pointed downward from a horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
- B. Insulation: Where insulation is indicated, install extended stem valves, arranged in the proper manner to receive insulation.
- C. Applications Subject to Shock: Install valves with bodies of metal other than cast iron where thermal or mechanical shock is indicated or can be expected to occur.

- D. Applications Subject to Corrosion: Do not install bronze valves and valve components in direct contact with steel, unless the bronze and steel are separated by a dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.
- E. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections:
 - 1. Tube Size 2" and smaller: Solder joint valves.
 - 2. Pipe Size 2" and smaller: One of the following, at the installer's option:
 - a. Threaded Valves
 - b. Butt Welding Valves
 - c. Socket Welding Valves
 - d. Flanged Valves
 - e. Flangeless Valves
 - f. Single Flange Valves
 - 3. Pipe Size 2-1/2" and Larger: One of the following, at the installer's option:
 - a. Butt Welding Valves
 - b. Socket Welding Valves
 - c. Flanged Valves
 - d. Flangeless Valves
 - e. Single Flange Valves
- F. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.
- G. Non-Metallic Disc: Limit the selection and installation of valves with non-metallic discs to locations indicated and where foreign material in the piping system can be expected to prevent tight shut off of metal seated valves.
- H. Renewable Seats: Select and install valves with renewable seats, except where frequent usage of the valves is indicated.
- I. Lubricant Seal: Select and install plug valves with lubricant seal except where frequent usage is indicated or can be reasonably expected to occur.
- J. Fluid Control: Except as otherwise indicated, install gate ball, globe plug, and butterfly valves to comply with ANSI B31. Where throttling is indicated or recognized as the principal reason for the valve, install a globe plug or butterfly valves.

3.6 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.

B. Hanger Spacing for Steel Piping.

1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.

C. Hanger Spacing for Plastic Piping.

1. 1/2 inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
2. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
3. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.

END OF SECTION 232113

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SECTION 232114 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air vents.
- B. Strainers.
- C. Balancing valves.

1.2 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping
- B. Section 23 2500 - HVAC Water Treatment

1.3 REFERENCE STANDARDS

- A. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2010.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 See Division 1 for additional requirements.

2.2 AIR VENTS

A. Manufacturers:

- 1. Armstrong International, Inc: www.armstronginternational.com.
- 2. ITT Bell & Gossett: www.bellgossett.com.
- 3. Taco, Inc: www.taco-hvac.com.

B. Float Type:

- 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- 2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.3 STRAINERS

A. Manufacturers:

- 1. Armstrong International, Inc: www.armstronginternational.com.
- 2. Flexicraft Industries: www.flexicraft.com.
- 3. Grinnell Mechanical Products, a Tyco International Co: www.grinnell.com.
- 4. The Metraflex Company: www.metralflex.com.

B. Size 2 inch and Under:

- 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:

1. Provide flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:

2.4 BALANCING VALVES

A. Manufacturers:

1. Armstrong International, Inc: www.armstronginternational.com.
2. ITT Bell & Gossett: www.bellgossett.com.

B. Size 2 inch and Smaller:

1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded or soldered connections.
2. Metal construction materials consist of bronze or brass.
3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.

C. Size 2.5 inch and Larger:

1. Provide ball or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, or weld end connections.
2. Valve body construction materials consist of cast iron or ductile iron.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.5 VALVE INSTALLATION KITS:

- A. In lieu of individual valves, strainers, and balancing valves, valve installation kits are acceptable for use for pipe sizes up to 2".
- B. Valve kits shall be as supplied by Bell & Gossett, Nexus, Nutech or approved equal.
- C. Supply valve kits shall be B & G Model UBY or equal. Kit to include combination wye strainer and shutoff valve with pressure temperature test port, drain valve, tailpiece, and union end.
- D. Return valve kits shall be B & G Model MC, Nutech or equal. Kit to include calibrated balance and shut off valve with two pressure temperature test ports, tail piece, and union end.

2.6 FLOW METERS

A. Manufacturers:

1. Armstrong International, Inc: www.armstronginternational.com.
2. ITT Bell & Gossett: www.bellgossett.com.

- B. Portable meter consisting of case containing one, 3 percent accuracy pressure gage with 0-60 feet pressure range for 500 psi maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points and as indicated.
- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Provide valved drain and hose connection on strainer blow down connection. Provide caps with gaskets on discharge.
- E. Provide pump suction fitting on suction side of base mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems. Fitting shall include support feet.

3.2 MAINTENANCE

- A. See Division 1 - Execution Requirements, for additional requirements relating to maintenance service.
- B. Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION 232114

SECTION 232115 - PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements (if any) apply to the work specified in this section.

1.2 DESCRIPTION OF WORK:

- A. The requirements of this section, apply to the piping work specified elsewhere in these specifications.
- B. This Section specifies quality and types of materials, but not their application to specific piping systems. Refer to other Division 15 sections for which specific piping and fitting types that can be used in those systems.

1.3 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in the manufacture of piping products of types and sizes required, and which have been in satisfactory use for not less than five years. in similar service.
- B. Welding: Certify welding procedures, welders and operators in accordance with ANSI B31.1, paragraph 527.5 for shop and job site welding of piping work.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Provide factory applied plastic end caps on each length of all pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe end damage and eliminate dirt and moisture from outside of pipe and tube.
- B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate well above grade and enclose with durable waterproof wrapping.
- C. Protect steel flanges and fittings from moisture and dirt by inside storage and enclosure or packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS:

2.1 STEEL PIPE AND COPPER TUBE:

- A. General: Provide pipe and tube of the type, grade, size and weight (wall thickness) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by installer for installation requirements and complying with codes.
- B. Black Steel Pipe: ASTM A 53, Schedule 40.
- C. Galvanized Steel Pipe: ASTM A 530, Schedule 40.
- D. Copper Tube: ASTM B 88, type as indicated for each service; hard drawn temper, except as otherwise indicated.
- E. DWV Copper Tube: ASTM B 306.

2.2 FITTINGS FOR STEEL PIPE AND COPPER TUBING:

- A. General: Provide factory fabricated fittings of type, grade, class and pressure rating indicated for each service. Provide sizes and types matching pipe, tube, valve, and equipment connections.
- B. Malleable Iron Threaded Fittings: ANSI B16.3, Class 150 and 300, plain or galvanized.
- C. Malleable Iron Threaded Unions: MSS SP-76; selected by installer for proper piping fabrication and service requirements, including style, end connections, and metal to metal seats (iron, bronze, or brass) classes 150, 250, and 300.
- D. Threaded Pipe Plugs: ANSI B16.14.
- E. Steel Flanges and Flanged Fittings: ANSI B16.5 including bolting and gasketing of the material group, 1.1, butt weld end connection and raised facing, except as otherwise indicated.
- F. Wrought Steel Buttwelding Fittings: ANSI 1316.9, except ANSI B16.28 for short radius elbows and return; rated to match connected pipe.
- G. Cast Bronze Solder Joints: ANSI B16.22.
- H. Cast Bronze Solder Drainage Fittings: ANSI B16.22.
- I. Anvil Stainless Steel Joint Fittings.
- J. Wrought Copper Solder Joint Fittings: ANSI B16.22.

K. Wrought Copper Solder Joint Drainage Fittings: ANSI B16.29.

L. MISCELLANEOUS FABRICATION MATERIALS:

1. Forged Branch Connection Fittings: Except as otherwise indicated, provide the type as determined by the installer to comply with installation requirements.
2. Pipe Nipples: Fabricate from same pipe as used for connected pipe; except do not use less than schedule 80 pipe where length remaining unthreaded is less than 1 1/2", and where pipe size is less than 1 1/4", and do not thread nipples full length (no close nipples.)
3. Copper Tube Unions: Provide standard products recommended by the manufacturer for use in the service indicated.
4. Welding Materials: Except as otherwise indicated, provide welding materials as determined by the installer to comply with installation requirements. Comply with Section 2-C, ASME Boiler Code for welding materials.
5. Soldering Materials: Except as otherwise indicated, provide lead free soldering materials as determined by the installer to comply with installation requirements.
6. Tin-Antimony Solder: ASTM B32, Grade 95YA.
7. Gaskets for Flanged Joints: ANSI B16.21 full faced for cast iron flanges; raised face for steel flanges, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. General: Install pipe, tube and fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connection, within 1/16" misalignment tolerance.
- B. Comply with ANSI B31 Code for Pressure Piping.
- C. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanently enclosed elements of the building; limit clearance to 0.5" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 2.0" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal piping from view by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

- D. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical equipment spaces and enclosures.
- E. Piping System Joints: Provide joints of the type indicated in each piping system.
- F. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Read threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound/tape on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
- G. Solder copper tube and fittings joints in accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens.
- H. Weld pipe joints in accordance with ANSI B31.
- I. Flanged Joints: Match flanged within piping systems, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

3.2 INSPECTION:

- A. General: Clean exterior surfaces of installed piping systems of superfluous materials and prepare for application of specified coatings if any. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

3.3 PIPING TESTS:

- A. General: Provide temporary equipment for testing, including pumps and gages. Test piping system before insulation is installed wherever feasible and remove control devices before testing.
- B. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
- C. Required test period is 2 hours.
- D. Test each piping system at 150% of operating pressure indicated, but not less than 25 psi test pressure.
- E. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

- F. Repair piping systems sections which fail the required piping tests by disassembly and reinstallation, using new materials to the extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics or other temporary repair methods.
- G. All tests to be witnessed by the Owner's representative.

3.4 COORDINATION:

- A. Prepare coordination drawings showing all piping, fittings, hangers, valves, etc.
- B. Show work of other contractors on coordination drawings.

END OF SECTION 232115

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SECTION 232116 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to the work of this section.

1.2 DESCRIPTION OF WORK:

- A. Extent of piping specialties required by this section is indicated on drawings and/or specified in other Division 23 sections.
- B. Types of piping specialties specified in this section include the following:
- C. Pipe Escutcheons.
- D. Pipeline Strainers.
- E. Drip Pans.
- F. Sleeves.
- G. Sleeve Seals.

- 1.3 Piping specialties furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other sections.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in the manufacture of piping products of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.1 MANUFACTURED PIPING SPECIALTIES:

- A. General: Provide factory fabricated piping specialties recommended by the manufacturer for use in the service indicated. Provide piping specialties of the type and pressure rating indicated for each service or, if not indicated provide proper selection as determined by the installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is Installer's option.

2.2 PIPE ESCUTCHEONS:

- A. General: Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime paint finish for unoccupied area.
- B. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons, solid or split hinged.
- C. Pipe Escutcheon for Dry Areas: Provide sheet steel escutcheons, solid or split hinged.

2.3 LOW PRESSURE Y-TYPE PIPELINE STRAINERS:

- A. General: Comply with FCI 73-1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi working pressure, with Type 304 stainless steel screens, with 3/64" perforations @ 233 per sq. in.
- B. Threaded Ends, 2" and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.
- C. Threaded Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-centered blowdown fitted with pipe plug.
- D. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted pipe plug.
- E. Manufacturer: Subject to compliance with requirements, provide low pressure Y-Type strainers of one of the following:
 - 1. Armstrong Machine Works.
 - 2. Hoffman Specialty, ITT Fluid Handling Div.
 - 3. Metraflex Co.
 - 4. Sarco Co., Div. of White Consolidated.
 - 5. Trerice (H.O.) Co.

2.4 FABRICATED PIPING SPECIALTIES:

- A. DRIP PANS: Provide drip pans fabricated from corrosion-resistant sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top either by structural angles or by rolling top over 1/4" steel rod. Provide hole, gasket, and flange at low point for watertight joint and 1" drain line connection.
- B. PIPE SLEEVES: Provide pipe sleeves of one of the following:

1. Sheet Metal Pipe Sleeves: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" and smaller, 20 gauge; 4" to 6", 16 gauge; over 6" pipe, 14 gauge.
- C. Steel Pipe: Fabricate from schedule 40 galvanized steel pipe; remove burrs.
- D. Iron Pipe Sleeves: Fabricate from cast-iron or ductile-iron pipe; remove burrs.
- E. Plastic-Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
- 2.5 SLEEVE SEALS: Provide sleeve seals for sleeves located in foundation walls below grade, or in exterior walls, of one of the following:
 - A. Lead and Oakum: Calked between sleeve and pipe.
 - B. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
 - C. Manufacturer: Subject to compliance with requirements, provide mechanical sleeve seals from the Thunderline corporation.

PART 3 - EXECUTION

3.1 INSTALLATION OF MANUFACTURED PIPING SPECIALTIES:

- A. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration thru floors, walls, partitions, and ceilings where penetration is exposed to view; and on exterior of building. Secure escutcheon to pipe or insulation so escutcheon covers penetration hole, and is flush with adjoining surface.
- B. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and shutoff valve in strainer blow down connection, full size of connection with hose connection and cap, except for strainers 2" and smaller installed ahead of control valves feeding individual terminals.
- C. Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:
 1. Pumps.
 2. Temperature control valves.
 3. Pressure reducing valves.
 4. Temperature or pressure regulating valves.

3.2 INSTALLATION OF FABRICATED PIPING SPECIALTIES:

- A. Drip Pans: Locate drip pans under piping passing over or within 3' horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, weld rods to sides of drip pan. Brace to prevent sagging or swaying. Connect 1" drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.
- B. Sleeves: Install pipe sleeves of the types indicated wherever piping passes through walls, floors, ceiling, roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as reviewed by Architect/Engineer. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and allowance for thermal expansion; but not less than 2 pipe sizes larger than piping run. Where insulation includes a vapor barrier jacket provide sleeve with sufficient clearance for installation. Install length of sleeve equal to thickness of construction penetrated, and finish flush to surface; except floor sleeves. Extend floor sleeves 1/4" above level floor finish, and 3/4" above floor finish sloped to drain. Provide temporary support of sleeves during placement of concrete and other work around sleeves, and provide temporary closure to prevent concrete and other materials from entering pipe sleeves.
 - 1. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings.
- C. Install iron-pipe sleeves at exterior penetrations, both above and below grade.
- D. Install steel-pipe sleeves except as otherwise indicated.

END OF SECTION 232116

SECTION 232117 - PIPE HANGERS, SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This section specified hangers, supports and anchors for use in piping systems installed in other sections of these specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Grinnell
- B. Approved Equal.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS:

- A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports of the MSS type and size indicated, bolts (if any) and washers; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information: size hangers and supports properly for piping including insulation, if any.
- B. Adjustable Band Hangers: MSS Type 7, fabricated from steel.
- C. Adjustable Swivel Band Hangers: MSS Type 10.
- D. Clamp: MSS Type 4.
- E. Double Bolt Clamp: MSS Type 3, including pipe spacers.

2.3 VERTICAL PIPING CLAMPS:

- A. General: Except as otherwise indicated, provide factory fabricated vertical piping clamps of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection as determined by the installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size clamps properly for piping, including insulation (if any).
- B. Two Bolt Riser Clamp: MSS Type 8.

2.4 HANGER ROD ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory fabricated hanger rod attachments of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where MSS type or size is not indicated, provide proper selection as determined by installer for installation requirements, and comply with MSS AP-69 and the manufacturer's published product information. Size attachments properly for piping, including insulation (if any).
- B. Turnbuckles: MSS Type 13.
- C. Weldless Eye Nut: MSS Type 17.
- D. Malleable Eye Socket: MSS Type 16.
- E. Clevises: MSS Type 14.

2.5 BUILDING ATTACHMENTS:

- A. General: Except as otherwise indicated, provide factory fabricated building attachments of the MSS type and load rating indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or load rating is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published information. Size units properly for piping loading.
- B. Concrete Inserts: MSS Type 18, steel.
- C. Top Beam C-Clamps: MSS Type 19.
- D. C-Clamps: MSS Type 23, steel
- E. Top I-Beam Clamp: MSS Type 25.
- F. Side Beam Clamp: MSS Type 20.
- G. Beam Clamp/Eye Nut: MSS Type 28.
- H. Wide Flange Beam Clamp/Eye Nut: MSS Type 29.
- I. Beam Clamp/Extension Piece: MSS Type 30.

2.6 SADDLES AND SHIELDS:

- A. General: Except as otherwise indicated, provide factory fabricated saddles and shields of the MSS type and size indicated; comply with MSS SP-58 and the manufacturer's published product information. Where the MSS type or size is not indicated, provide proper selection determined by installer for installation requirements, and comply with MSS SP-69 and the manufacturer's published product information. Size saddles and shields properly for insulation and vapor barriers (if any).
- B. Protection Saddles: MSS Type 39.
- C. Protection Shields: MSS Type 40.
- D. High Density Insert Insulation Saddles: Provide products manufactured by Elcen Metal Products Company.

2.7 MISCELLANEOUS MATERIALS:

- A. Metal Framing: Provide products complying with NEMA STD ML 1.
- B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

PART 3 - EXECUTION

3.1 PREPARATION:

- A. Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building attachments.

3.2 INSTALLATION OF BUILDING ATTACHMENTS:

- A. Install building attachments at the required locations within concrete or onto structural steel for proper piping support. Space attachments within the maximum piping span length indicated in MSS SP-69. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the top of inserts. Prior to placing concrete, install nut in insert and screw threaded rod thru nut until rod is firmly against top of the insert body.

3.3 INSTALLATION OF HANGERS AND SUPPORTS:

- A. General: Install hangers, supports, clamps and attachments to support piping properly from the building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with the maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together with trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire of perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
- C. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.

3.4 Provisions for movement:

- A. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units.
- B. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 1. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded.
- C. Insulated Piping: Comply with the following installation requirements:
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through the insulation; do not exceed pipe stresses allowed by ANSI B31.
 - 2. Shields: Where low compressive strength insulation of vapor barriers are indicated on chilled water piping, install coated protective shields.
 - 3. Saddles: Where insulation without vapor barrier is indicated (hot water piping), install protection saddles.

3.5 HYDRONIC PIPING

- A. Conform to ASTM F708, MSS SP58, MSS SP69, MSS SP 89.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2". Malleable iron adjustable swivel, split ring.
- C. Hangers for Cold Pipe Sizes 2" and Over: Carbon steel, adjustable, clevis.

- D. Hangers for Hot Pipe Sizes 2 to 4". Carbon steel, adjustable, clevis.
 - E. Hangers for Hot Pipe Sizes 6" and Over: Adjustable steel yoke, cast iron roll, double hanger.
 - F. Multiple or Trapeze Hangers. Steel channels with welded spacers and hanger rods.
 - G. Multiple or Trapeze Hangers for Hot Pipe Sizes 6" and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
 - H. Wall Support for Pipe Sizes to 3". Cast iron hook.
 - I. Wall Support for Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp.
 - J. Wall Support for Hot Pipe Sizes 6" and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
 - K. Vertical Support: Steel riser clamp.
 - L. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - M. Floor Support for Hot Pipe Sizes to 4": Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - N. Floor Support for Hot Pipe Sizes 6" and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 - O. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- 3.6 ADJUSTMENT OF HANGERS AND SUPPORTS:
- A. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

END OF SECTION 232117

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SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning & filling of piping systems.
- B. Chemical treatment.

1.2 RELATED SECTIONS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2114 - Hydronic Specialties.

1.3 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- E. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- F. Certificate: Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.
- G. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
- H. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Division 1 - Product Requirements, for additional provisions.

2. Sufficient chemicals for treatment and testing during required maintenance period.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum five years of documented experience. Company shall have local representatives with water analysis laboratories and full-time service personnel.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience and approved by manufacturer.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.6 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for one year from Date of Substantial Completion. Include monthly service visits and all chemicals
- B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- C. Provide laboratory and technical assistance services during this maintenance period.
- D. Include two-hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start-up of systems.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.7 MAINTENANCE MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Supply sufficient chemicals for treatment and testing during warranty and service period.

- C. Provide chemicals for additional 1-year from warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Proasys (District's current vendor).

2.2 MATERIALS

A. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite.

B. Closed System Treatment (Water):

1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.

2.3 BY-PASS (POT) FILTER/FEEDER

- A. 5.0 gallon with quick opening cap and 20 micron and 5 micron filter bags. Provide 20 of each type of filter bag for the Owner's use.

2.4 SOLUTION METERING PUMP

A. Manufacturers:

1. J. L. Wingert
2. Neptune Chemical Pump Company
3. Pulsafeeder, Inc

- B. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.

2.5 SOLUTION TANKS

- A. 30 gallon capacity, polyethylene, self-supporting, one gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch for the open system.
- B. Five gallon "carboy" tanks for chilled water and hot water closed systems for chemical storage.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.

3.2 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by CLEANER manufacturer.
- B. Hot Water Heating Systems:
 - 1. Add cleaner, apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
 - 5. Test water sample to verify cleaner is removed.
- D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect.
- E. Flush open systems with clean water for one hour minimum. Drain completely and refill.
- F. Remove, clean, and replace strainer screens.
- G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- H. System shall flushed, treated, and tested in accordance with the phasing. Multiple phased treatments will be required.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide pipe cleaning and chemical treatment as required to ensure that all piping systems are cleaned and treated prior to being placed in service.
- C. Provide monthly technical service visits during the construction period as specified under "MAINTENANCE SERVICE":

3.4 CLOSED SYSTEM TREATMENT

- A. Provide bypass filter/feeder as indicated on drawings. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. For chilled water, provide bypass feeders in mechanical room.
- D. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens. Provide one for each bypass filter/feeder location (to be verified by water treatment company).

3.5 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
 - 1. Provide minimum of two hours of instruction for two people.
 - 2. Have operation and maintenance data prepared and available for review during training.
 - 3. Conduct training using actual equipment after treated system has been put into full operation.

3.6 MAINTENANCE

- A. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.
- B. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.
- C. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- D. Provide laboratory and technical assistance services during this maintenance period.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION 232500

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Casing and plenums.
- C. Duct Liner.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 09 9000 - Painting and Coating: Weld priming, weather resistant, paint or coating.
- C. Section 23 0713 - Duct Insulation: External insulation and duct liner.
- D. Section 23 3300 - Air Duct Accessories.
- E. Section 23 3700 - Air Outlets and Inlets.

1.3 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; 2009.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2008.
- C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications; 2012.
- D. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2012.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2011.
- F. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.

- G. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2010.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2012.
- I. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2012.
- J. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association; 2012.
- K. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; National Fire Protection Association; 2011.
- L. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2012, 2nd Edition.
- M. SMACNA (DCS) - HVAC Duct Construction Standards; 2005.
- N. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication & Installation Guidelines; 2001.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A standards.

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES

- A. All Ducts: Galvanized steel, unless otherwise indicated.
- B. Low Pressure Supply (System with Cooling Coils): 2 inch w.g. pressure class, galvanized steel.
- C. Medium and High Pressure Supply (Upstream of VAV terminals): 4-inch w.g. pressure class, galvanized steel.
- D. Return, and Relief: 2-inch w.g. pressure class, galvanized steel.
- E. General Exhaust: 2-inch w.g. pressure class, galvanized steel.
- F. Outside Air Intake: 2-inch w.g. pressure class, galvanized steel.
- G. Transfer Ducts and Sleeves: 1-inch w.g. pressure class, galvanized steel.

2.2 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
- C. Stainless Steel for Ducts: ASTM A 240/A 240M, Type 304.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.
- E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- F. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Screw Type Anchors: Complying with ICC-ES AC193.

2.3 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Provide turning vanes of perforated metal with closed cell foam insulation when acoustical lining is indicated.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards.
- F. Seal all joints and fittings

2.4 MANUFACTURED DUCTWORK AND FITTINGS

- A. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
 - 1. Manufacture in accordance with SMACNA HVAC Duct Construction Standards.
 - 2. Insulation:
 - a. Thickness: 1.0 inch
 - b. Material: Fiberglass.
 - 3. Manufacturers:
 - a. AMPCO by Commercial Products Group of Hart & Cooley, Inc: www.ampcostacks.com.
 - b. Selkirk Corporation: www.selkirkcorp.com.
- B. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
 - 1. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
 - 2. Maximum Velocity: 4000 fpm.
 - 3. Temperature Range: -20 degrees F to 210 degrees F.
- C. Double Wall Rectangular Ducts: Rectangular double wall ducts shall have a solid galvanized steel outer shell and a perforated inner liner, separated with a 1.0" thick fiberglass insulating layer. Fittings shall have solid inner walls. Double wall ducts shall be 18-gauge thick construction.

2.5 DUCT LINER

A. Manufacturers:

1. Knauf Fiber Glass: www.knauffiberglass.com.
2. Approved equal:

B. Flexible, mat-faced bonded insulation with encapsulated edge coating.

1. Thermal Performance: 1.5" thickness; R-value 6.0 (hr-sqft-F/Btu) or 0.17 conductness.
2. Service temperature: up to 250 degrees F.
3. Rated velocity on coated side for air erosion: 6,000 fpm minimum.
4. Minimum noise reduction coefficients: 1.5 inch thickness; 0.80.

C. Liner Fasteners: Galvanized steel, welded with integral head.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards.
- B. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- E. Duct and Plenum Liner Application:
 1. Adhere insulation with adhesive for 100 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for spacing.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.2 SCHEDULES

A. Lined Ductwork:

1. 1.5" thick duct liner for supply ductwork where duct liner is indicated on the drawings.
 2. Return air duct liner shall be 1.5" thick where shown on the drawings.
 3. All transfer ducts shall be lined with 1" thick liner.
- B. Double Wall Ducts: Provide double-wall ductwork for all exposed supply and exhaust/return air ductwork systems where indicated on the plans.

END OF SECTION 233100

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers.
- C. Duct access doors.
- D. Duct test holes.
- E. Flexible duct connections.
- F. Volume control dampers.

1.2 RELATED SECTIONS

- A. Section 23 3100 - HVAC Ducts and Casings.
- B. Section 23 3600 - Air Terminal Units.

1.3 REFERENCES

- A. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 2009.
- B. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- C. UL 33 - Heat Responsive Links for Fire-Protection Service; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- D. UL 555 - Standard for Fire Dampers; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.
- E. UL 555S - Standard for Leakage Rated Dampers for Use in Smoke Control Systems; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide for shop fabricated assemblies including volume control dampers and duct access doors.
- C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers and duct access doors.
- D. Manufacturer's Installation Instructions: Provide instructions for fire dampers and smoke dampers..

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of access doors and test holes.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

1.8 EXTRA MATERIALS

- A. Provide two of each size and type of fusible link.

PART 2 - PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS - AIRFOIL TYPE

- A. Manufacturers:
 - 1. Ruskin Company: www.ruskin.com.
 - 2. Titus: www.titus-hvac.com.
- B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with worm drive mechanism with removable key operator.

2.2 BACKDRAFT DAMPERS

- A. Manufacturers:
 - 1. Louvers & Dampers, Inc: www.louvers-dampers.com.

2. Nailor Industries Inc: www.nailor.com.
3. Ruskin Company: www.ruskin.com.

- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: galvanized steel, with center pivoted blades of maximum 6 inch width, with flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 DUCT ACCESS DOORS

- A. Manufacturers:

1. Ruskin Company: www.ruskin.com.
2. Approved Equal.

- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

- C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.

1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Provide two hinges and two sash locks.
3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
4. Larger Sizes: Provide an additional hinge.

- D. Access doors with sheet metal screw fasteners are not acceptable.

2.4 DUCT TEST HOLES

- A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

- B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

- B. Flexible Duct Connections: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - a. Net Fabric Width: Approximately 2 inches wide.
2. Metal: 3 inches wide, 24 gage thick galvanized steel.

2.6 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Louvers & Dampers, Inc: www.louvers-dampers.com.
2. Nailor Industries Inc: www.nailor.com.
3. Ruskin Company: www.ruskin.com.

B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.

C. Splitter Dampers:

1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.

D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.

G. Quadrants:

1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches provide regulator at both ends.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 3100 for duct construction and pressure class.

- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A. Provide control wiring.
- G. Demonstrate re-setting of fire dampers to Owner's representative.
- H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- J. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- K. Use splitter dampers only where indicated.
- L. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- M. Provide turning vanes, Air Turning Devices, at all elbows greater than 45 degrees and all radiused elbows.
 - 1. Provide Blades: 2" galvanized steel for up to and including 18" ducts.
 - 2. Blades: 4 1/2" galvanized for ducts over 18"
 - 3. Construction: Double wall blade.
 - 4. Types: Gang operated blades with removable hex key.
 - 5. Types: Gang operated blades with removable lever.
 - 6. Types: Fixed blades for 90 degree elbows.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1- GENERAL

1.1 SECTION INCLUDES

- A. Centrifugal Ceiling Exhaust and Cabinet Fans.
- B. Centrifugal Inline Fans.
- C. Centrifugal Roof Downblast Exhaust Fans

1.2 RELATED SECTIONS

- A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 3300 - Air Duct Accessories: Backdraft dampers.

1.3 REFERENCES

- A. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association International, Inc.; 2007 (ANSI/AMCA 210, same as ANSI/ASHRAE 51).
- C. AMCA (DIR) - [Directory of] Products Licensed Under AMCA International Certified Ratings Program; Air Movement and Control Association International, Inc.; <http://www.amca.org/licenses/search.aspx>.
- D. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; Air Movement and Control Association International, Inc.; 2008.
- E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; Air Movement and Control Association International, Inc.; 2006.
- F. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- H. UL 705 - Power Ventilators; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96 and the International Mechanical Code.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Permanent ventilators may not be used for ventilation during construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Greenheck.
- B. Loren Cook Company.
- C. PennBarry.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Greenheck: www.greenheck.com.

B. Loren Cook Company: www.lorencook.com.

C. PennBarry: www.pennbarry.com.

2.2 POWER VENTILATORS - GENERAL

- A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301, tested to AMCA 300, and bearing AMCA Certified Sound Rating Seal.
- D. Fabrication: Conform to AMCA 99.
- E. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- G. Enclosed Safety Switches: Conform to NEMA 250.

2.3 CENTRIFUGAL ROOF DOWNBLAST EXHAUST FANS

- A. General Description:
 - 1. Fan shall be downblast type and shall be for roof mounted applications
 - 2. Maximum continuous operating temperature shall be a minimum of 180 Fahrenheit (82.2 Celsius)
 - 3. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.
- B. Wheel:
 - 1. Constructed of aluminum
 - 2. Non-overloading, backward inclined centrifugal
 - 3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
 - 4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
- C. Motors:
 - 1. Electronically Commutated Motor
 - a. Motor enclosure: ODP
 - b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable.

- c. Motors shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
 - d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
 - e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 - f. Motor shall be a minimum of 85% efficient at all speeds
2. AC Induction Motor (Belt Driven Fans)
- a. Motor enclosure: ODP
 - b. Motors are permanently lubricated, heavy duty ball bearing type to match the fan load and pre-wired to the specific voltage and phase.
 - c. Accessible for maintenance.

D. Shaft and Bearings (Belt Driven Fans):

- 1. Fan Shaft shall be ground and polished solid steel with an anti-corrosive coating
- 2. Permanently sealed bearings or pillow block ball bearings
- 3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
- 4. Bearings are 100 percent factory tested
- 5. Fan Shaft first critical speed is at least 25 percent over maximum operating speed

E. Housing:

- 1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum
- 2. Shroud shall have an integral rolled bead for extra strength
- 3. Shroud shall be drawn from a disc and direct air downward
- 4. Lower windband shall have a formed edge for added strength
- 5. Motor cover shall be drawn from a disc
- 6. All housing components shall have final thicknesses equal to or greater than preformed thickness
- 7. Curb cap shall have pre-punched mounting holes to ensure correct attachment
- 8. Rigid internal support structure
- 9. Leak proof

F. Housing Supports and Drive Frame:

- 1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

G. Vibration Isolation:

- 1. Rubber isolators
- 2. Sized to match the weight of each fan

H. Disconnect Switches:

- 1. NEMA rated: NEMA 1: indoor application no water. Factory standard.

2. Positive electrical shut-off
3. Wired from fan motor to junction box installed within motor compartment

I. Drive Assembly (Belt Driven Fans):

1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower
2. Belt: Static free and oil resistant
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts
4. Motor pulleys are adjustable for final system balancing
5. Readily accessible for maintenance

J. Accessories:

1. Birdscreen:
 - a. Material Type: Galvanized
 - b. Protects fan discharge
2. Roof Curbs:
 - a. Welded, straight sided curb with 2 inches of flashing flange and wood nailer
 - b. Material: Galvanized
 - c. Height: 18"
 - d. Insulation thickness: 1.5 inches
3. Dampers:
 - a. Gravity backdraft damper
 - b. Prevents outside air from entering back into the building when fan is off
 - c. Balanced for minimal resistance to flow
 - d. Galvanized frames with prepunched mounting holes
4. Variable Frequency Drive (Belt Driven Fans):
 - a. Factory programed, mounted and wired
 - b. Input speed control: On-Board Dial
 - c. 24VDC damper power output
 - d. Motor: (VFD Rated) compatible with induction and permanent magnet motors
 - e. Parameters of acquainted motor shall be set to include voltage, speed, FLA, acceleration/deceleration time, and minimum and maximum motor frequency
 - f. R3 Filtering for harmonic mitigation
 - g. UL Recognized for 3 phase input at 380V-480V
 - h. NEMA 4X Enclosure
 - i. LED indication for Power, Run, and Fault

2.4 CENTRIFUGAL CEILING EXHAUST AND CABINET FANS

A. General Description:

1. Fan shall be for ceiling mounted applications
2. Fan maximum operating temperature shall be a minimum of 130 Fahrenheit (54.4 Celsius)
3. UL/cUL listed 507 - Electric Fans

4. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number
- B. Wheel:
1. Forward curved centrifugal wheel
 2. Constructed of galvanized steel
 3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
- C. Motors:
1. Motor enclosures shall be open driproof (ODP), opening in the frame body and or end brackets
 2. Motors are permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase
 3. Motor shall be mounted on vibration isolators and be accessible for maintenance
 4. Thermal overload protection
- D. Housing:
1. Constructed of heavy gauge galvanized steel
 2. Interior shall be lined with 0.5 inches of acoustical insulation
- E. Spring Loaded Aluminum Backdraft Damper:
1. Prevents air from entering back into the building when fan is off
 2. Eliminates rattling or unwanted backdrafts
- F. Grille:
1. Types: Aluminum
- G. Accessories:
1. Provide unit mounted disconnect switch.
 2. Provide Speed controller.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counter flash duct to roof opening.
- D. Provide sheaves required for final air balance.
- E. Install backdraft dampers on inlet to roof and wall exhausters, except kitchen hood fans.

- F. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- D. Provide sheaves required for final air balance.
- E. Install backdraft dampers on inlet to roof and wall exhausters, except kitchen hood fans.
- F. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Variable volume terminal units.
- B. Integral heating coils.

1.2 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping: Connections to heating coils.
- B. Section 23 2114 - Hydronic Specialties: Connections to heating coils.
- C. Section 23 3100 - HVAC Ducts and Casings.
- D. Section 23 3300 - Air Duct Accessories.

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilation Systems; National Fire Protection Association; 2012.
- B. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Division 1 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
 - 1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.
- D. Manufacturer's Installation Instructions: Indicate support and hanging details, and service clearances required.

- E. Project Record Documents: Record actual locations of units.
- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and complete parts lists. Include directions for resetting constant volume regulators.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.
- B. Provide warranty for a period of one year from the date of substantial completion of the entire project.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Enviro-Tec (Basis of Design).
- B. Trane.
- C. JCI.

2.2 MANUFACTURED UNITS

- A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with electronic variable volume controls, hot water heating coils.
- B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

2.3 SINGLE DUCT VARIABLE VOLUME UNITS

A. Basic Assembly:

1. Casings: Minimum 22 gage galvanized steel.
2. Lining: Minimum 1/2 inch thick neoprene insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements. Face lining with mylar film.
3. Plenum Air Inlets: Round stub connections for duct attachment.
4. Plenum Air Outlets: S slip and drive connections.

B. Basic Unit:

1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.

C. Hot Water Heating Coil:

1. Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.

D. Automatic Damper Operator:

1. Electric Actuator: 24 volt with high limit.

E. Velocity Reset Controller and Probe:

1. Provide velocity probes for connection to the BMS controller.

F. Controls shall be provided by the BMS supplier and shall be factory installed on the VAV boxes by the manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Support units individually from structure. Do not support from adjacent ductwork.
- C. Connect to ductwork in accordance with Section 23 3100.

END OF SECTION 233600

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SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers/grilles.
- C. Roof hoods and vents.

1.2 REFERENCES

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.; 2007.
- B. ARI 890 - Standard for Air Diffusers and Air Diffuser Assemblies; Air-Conditioning and Refrigeration Institute; 2008.
- C. ASHRAE Std 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets; American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.; 2006.
- D. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.

1.3 SUBMITTALS

- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- B. Project Record Documents: Record actual locations of air outlets and inlets.

1.4 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Price Industries.
- B. Titus.
- C. Metalaire.
- D. Krueger.

2.2 RECTANGULAR CEILING DIFFUSERS

- A. Description: A square or rectangular inlet shall be an integral part of the frame assembly and a transition piece shall be available to facilitate attachment of round duct. An inner core assembly consisting of fixed deflection louvers shall be available in one-, two-, three- or four-way horizontal discharge patterns. Steel or aluminum induction blades shall be welded to each wing of the inner core. The induction blades shall be oriented at 45° angles in opposite directions to ensure rapid mixing of primary and room air. The inner core assembly must be removable in the field without tools for easy installation, cleaning or damper adjustment.
- B. Frame: Surface mount type. In ACT, where outer dimensions are 18x18 or greater, lay-in type shall be used.
- C. Color: As shown on drawings.
- D. Damper: Optional damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the diffuser by removing the spring loaded inner core assembly.

2.3 PERFORATED FACE CEILING DIFFUSERS

- A. Description: Diffusers shall have a perforated face with 3/16-inch diameter holes on 1/4-inch staggered centers and no less than 51 percent free area. Perforated face shall be steel or aluminum. The backpan shall be one piece stamped heavy gauge steel of the sizes and mounting types shown on the plans and outlet schedule. The diffuser neck shall have 1 1/8-inch depth for easy duct connection. Diffusers must discharge a uniform horizontal blanket of air into the room and protect ceiling against smudging. Pattern controllers in the supply models shall be mounted on the back of the perforated face and must be field adjustable to allow the discharged air to enter the room in either vertical or

one-, two-, three- or four-way horizontal jets. The perforated face must be easily unlatchable from the backpan to facilitate option of the face for pattern controller adjustment or to access an optional damper. The return models shall have the same face and border construction as the supply models for harmonious appearance in the room.

- B. Frame: Lay-in type.
- C. Color: As shown on drawings.
- D. Damper: Optional damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the diffuser by unlatching the diffuser face. The diffuser must be designed such that complete removal of the face is not required during damper adjustment.

2.4 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Description: Grilles shall have 3/4-inch blade spacing. The fixed deflection blades shall be available parallel to the long or short dimension of the grille. Construction shall be of extruded steel or aluminum with a 1¼-inch wide border on all sides. Minimum border thickness shall be 0.040-0.050 inch. Sizes 24 x 24 inches and smaller shall be constructed using a roll-formed frame. Corners shall be welded with full penetration resistance welds. Sizes larger than 24 x 24 inches shall be constructed by using heavy steel or aluminum extrusions and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be counter-sunk for a neat appearance. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed in place by crimping or welding. Blade deflection angle shall be available at 35°.
- B. Frame: Surface mounted with countersunk screw mounting. In ACT, where nominal dimensions are 18x18 or greater, lay-in type shall be used.
- C. Color: As shown on drawings.
- D. Damper: Optional opposed blade volume damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the grille.

2.5 WALL SUPPLY REGISTERS/GRILLES

- A. Type: Supply grilles shall be double deflection. The deflection blades shall be available parallel to the long dimension of the grille or register. Construction shall be of steel or aluminum with a 1¼-inch wide border on all sides. Sizes 24 x 24 inches and below shall have roll-formed borders with a minimum thickness of 0.032 inch. Larger sizes shall be constructed using continuous steel or aluminum extrusions with a nominal thickness of 0.040 through 0.050 inch and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Screw holes shall be countersunk for a neat appearance. Deflection blades shall be contoured to a specifically designed and tested cross-section

to meet published test performance data. Blades shall be spaced on 3/4-inch centers. Blades shall have friction pivots on both sides to allow individual blade adjustment without loosening or rattling or be inserted through the frame and held tight with steel friction wire interlocked to the frame on both ends of each side. Plastic blade pivots are not acceptable.

- B. Frame: Surface mounted with countersunk screw mounting.
- C. Color: As shown on drawings.
- D. Damper: Optional opposed blade volume damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the grille.

2.6 LINEAR SLOT DIFFUSERS

- A. Fabrication: Linear slot diffusers shall have slot spacing of the sizes and mounting types shown on the plans. Linear slot diffusers shall be available in standard one piece lengths up to 6 feet and 1 to 8 discharge slots. Diffuser lengths greater than 6 feet shall be furnished in multiple sections and will be joined together end-to-end with alignment pins to form a continuous slot appearance. All alignment components to be provided by the manufacturer.
- B. Frame: The frame and support bars shall be constructed of heavy gauge extruded aluminum. The pattern controller shall be an aerodynamically curved "ice-tong" shaped steel deflector capable of 180° pattern adjustment from the face of the diffuser and shall allow dampening if required. Maximum pattern controller length shall be 3 feet, for diffusers longer than 3 feet pattern controllers shall be furnished in multiple sections. Surface mount type with countersunk screw mounting for hard ceilings or lay-in mount type for ACT.
- C. Color: The face finish shall be as shown on the drawings and the pattern colors shall have a black finish.
- D. Accessories: Heavy gauge extruded aluminum end borders, end caps and mitered corners shall be available to close off the ends of the diffusers. Plenums shall be manufactured by the same manufacturer of the linear slot diffusers.

2.7 ROOF HOODS

- A. General Description:
 - 1. Ventilator is low silhouette for intake/relief applications.
- B. Hood and Base:
 - 1. Material Type: Aluminum.
 - 2. Hood Constructed of precision formed, arched panels with interlocking seams.
 - 3. Vertical end panels are fully locked into hood end panels.
 - 4. Base height is standard of 5 inches.
 - 5. Curb cap is six inches larger then throat size.

6. Curb cap has pre-punched mounting holes for installation.
- C. Birdscreen:
1. Constructed of ½ inch Aluminum mesh.
 2. Mounted horizontally across the intake area of the hood.
- D. Hood Support:
1. Constructed of galvanized steel and fastened so the hood can either be removed completely from the base or hinged open.
- E. Options/Accessories:
1. Roof Curbs:
 - a. Type: Welded, straight sided curb.
 - b. Material: Aluminum.
 - c. Insulation thickness: 2 inches.
 - d. Height: 18 inches.
 2. Dampers:
 - a. Type: As noted on the drawings.
 - b. Prevents outside air from entering back into the building when fan is off
 - c. Balanced for minimal resistance to flow
 - d. Galvanized frames with pre-punched mounting holes
 3. Insect Screen:
 - a. Constructed of fine mesh aluminum
 - b. Fitted to the top of the throat and prevents entry of insects

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location and sizes of outlets and inlets and make necessary adjustments in position and/or size to conform with architectural features, symmetry, lighting arrangement, and ceiling grid.
- C. Ceiling grilles and registers shall fit in tiles without infringing on the ceiling grid. Any discrepancies shall be reported prior to ordering the inlet/outlet.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

- F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9000.

END OF SECTION 233700

SECTION 234000 – HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Disposable panel filters.

1.2 RELATED SECTIONS

- A. Division 1 - Temporary Facilities and Controls: Filters for temporary heating and ventilating.
- B. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Division 1 – Summary of the Project.

1.3 REFERENCES

- A. ARI 850 - Commercial and Industrial Air Filter Equipment; Air-Conditioning and Refrigeration Institute; 2004.
- B. ASHRAE Std 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 1992.
- C. UL 900 - Standard for Air Filter Units; Underwriters Laboratories Inc.; 2004.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to ARI 850 Section 7.4.
 - 1. Dust Spot Efficiency: Plus or minus 5 percent.

1.5 SUBMITTALS

- A. See Division 1 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate assembly and change-out procedures.
- E. Operation and Maintenance Data: Include instructions for operation, changing, and periodic cleaning.

1.6 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 EXTRA MATERIALS

- A. See Division 1 - Product Requirements, for additional provisions.
- B. Provide two sets of disposable filters for each piece of HVAC equipment requiring air filters.

PART 2 PRODUCTS

2.1 FILTER MANUFACTURERS

- A. American Filtration Inc: www.americanfiltration.com.
- B. Camfil Farr Company: www.camfilfarr.com.

2.2 DISPOSABLE PANEL FILTERS

- A. Media: UL 900 Class 2, fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive.
 - 1. Nominal Size: 24 x 24 inches (610 x 610 mm).
 - 2. Thickness: 1 inch (25 mm).
- B. Performance Rating:
 - 1. Face Velocity: 500 FPM (2.54 m/sec).
 - 2. Initial Resistance: 0.15 inch WG (37 Pa).
 - 3. Recommended Final Resistance: 0.50 inches WG (125 Pa).
- C. Casing: Cardboard frame.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

END OF SECTION 234000

SECTION 237435 – PACKAGED ROOFTOP UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Packaged Rooftop Unit (RTU)

1.2 RELATED SECTIONS

- A. Section 23 0549 - Vibration Isolation & Seismic Mountings.
- B. Section 23 0924 - Building Automation System
- C. Section 23 0993 - HVAC Control Sequence
- D. Refer to the requirements of Division 1 and coordinate the division of responsibility of the work with Section 01 1000 - Summary of the Project.

1.3 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AMCA 99—Standards Handbook
- C. AMCA 210—Laboratory Methods of Testing Fans for Rating Purposes
- D. AMCA 500—Test Methods for Louver, Dampers, and Shutters.
- E. AHRI 340/360 - Unitary Large Equipment
- F. NEMA MG1—Motors and Generators
- G. National Electrical Code.
- H. NFPA 70—National Fire Protection Agency.
- I. SMACNA—HVAC Duct Construction Standards—Metal and Flexible.
- J. UL 900—Test Performance of Air Filter Units.

1.4 PERFORMANCE REQUIREMENTS

- A. Scheduled Performance: ARI 210/240 Test Conditions.

1.5 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data with dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.
- D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- E. Project Record Documents: Record actual locations of components.
- F. Operation And Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in School District's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.
- B. Startup must be done by trained personnel experienced with rooftop equipment.
- C. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters and remote controls are in place, bearings lubricated, and manufacturers' installation instructions have been followed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Accept products on site and inspect for damage.
- C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.8 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 WARRANTY

- A. The entire units shall be warranted by the manufacturer against defects in material and factory workmanship for 5 years. The warranties shall begin when the building has been determined to be substantially complete. Warranties shall include parts and labor.

1.10 EXTRA MATERIALS

- A. See Section 01 6000 - Project Requirements, for additional provisions.
- B. Provide two sets of filters.

PART 2 PRODUCTS

2.1 PACKAGED ROOFTOP UNITS: RTU

A. MANUFACTURERS

- 1. Basis of Design: Daikin Applied
- 2. Aeon
- 3. Trane
- 4. Valent

B. GENERAL DESCRIPTION

- 1. Furnish as shown on plans, Daikin Applied Rebel Cooling Unit(s) model DPS. Unit performance and electrical characteristics shall be per the job schedule.
- 2. Configuration: Fabricate as detailed on prints and drawings:
- 3. Return plenum / economizer section
- 4. Filter section
- 5. DX Cooling coil section
- 6. Supply fan section
- 7. Condensing unit section
- 8. The complete unit shall be cETLus listed.
- 9. The unit shall be ASHRAE 90.1-2019 compliant and labeled.

10. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-32 Refrigerant and oil.
11. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
12. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
13. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

C. CONSTRUCTION

1. Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0 on sizes 3-17 tons, and 2" thick with an R-value of 13 for 16-31 Tons, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.
2. Exterior surfaces shall be constructed of painted galvanized steel, for aesthetics and long-term durability. Paint finish will include a base primer with a high-quality polyester resin topcoat. Finished, unabraded panel surfaces shall be exposed to an ASTM B117 salt spray environment and exhibit no visible red rust at a minimum of 3,000 hours exposure. Finished, abraded surfaces shall be tested per ASTM D1654, having a mean scribe creepage not exceeding 1/16" at 1,000 hours minimum exposure to an ASTM B117 salt spray environment. Measurements of results shall be quantified using ASTM D1654 in conjunction with ASTM D610 and ASTM D714 to evaluate blister and rust ratings.
3. Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless-steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
4. The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal.

D. OUTDOOR /RETURN AIR SECTION

1. Daikin Applied UltraSeal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 1.5 CFM/Sq. Ft. of damper area at 1.0 inch static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a factory installed actuator.

2. Control of the outdoor dampers shall be by a factory installed actuator. Damper actuator shall be of the modulating type. Damper to open when supply fan starts, and close when supply fan stops.
3. Provide factory installed and tested, outdoor air monitor that controls outdoor air +/- 15% accuracy down to 40 cfm per ton.
4. Unit is provided with a factory installed and tested outdoor air monitor, with +/- 15% accuracy down to 40 cfm/ton, and a field installed Duct/Space mounted CO2 sensor. Outside air damper position will modulate between the Demand Control Ventilation Limit (minimum position setpoint) and the Ventilation Limit (maximum non-economizer position setpoint) to satisfy the space requirements. Damper position will be controlled to the greater of the two command signals, either minimum outside air flow or space IAQ (CO2).

E. FILTERS

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE MERV rating of 13, upstream of the cooling coil.
2. Unit shall include a clogged filter switch.

F. SUPPLY FAN

1. Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
2. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease lubricated ball bearings shall be used. Bearings shall be sized to provide a L-50 life at 250,000 hours. The entire fan assembly shall be isolated from the fan bulkhead with a flexible collar and mounted on 1" spring isolators.
3. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.
4. Supply fan and motor assembly shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.
5. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
6. The motor shall be T Frame and open drip proof. Overload protection and speed control is provided by the factory installed VFD and rooftop unit controller. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.
7. The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

G. RELIEF FAN

1. Dampers shall be sized for 100% relief.
2. Fans and motors shall be dynamically balanced.
3. Unit shall include barometric relief dampers.
4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.

H. COOLING COIL

1. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.
2. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
3. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.
4. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.
5. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.
6. A drain pan overflow safety shall shut off the unit and issue a warning before over flow occurs.

I. HOT GAS REHEAT

1. Unit shall be equipped with a fully modulating hot gas reheat coil with hot gas coming from the unit condenser.
2. Hot gas reheat coil shall be a Micro Channel design. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. The capacity of the reheat coil shall allow for a 15°F temperature rise at all operating conditions.
3. The modulating hot gas reheat systems shall allow for independent control of the cooling coil leaving air temperature and the reheat coil leaving air temperature. The cooling coil and reheat coil leaving air temperature setpoints shall be adjustable through the unit controller. During the dehumidification cycle the unit shall be capable of 100% of the cooling capacity. The hot gas reheat coil shall provide discharge temperature control within +/- 2°F.
4. Each coil shall be factory leak tested with high-pressure air under water.

J. VARIABLE AIR VOLUME CONTROL

1. The unit controller shall proportionally control the supply and exhaust fan motors. The supply fan shall be controlled to maintain an adjustable duct pressure setpoint. A duct static pressure sensor shall be factory mounted in the control panel. The field shall furnish and install duct static pressure sensor and the building pressure sensor. The field shall furnish and install the outdoor air pressure sensor. (RTU-1)
2. An electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the air stream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.
3. The unit manufacturer shall install all power and control wiring.
4. The supply air fan drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel.

K. CONDENSING SECTION

1. Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high-pressure air under water.
2. Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit in ambient conditions up to 125°F]. Mechanical cooling shall be provided to 0°F. Heat Pump Heating shall be provided to -10F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.
3. The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material.
4. The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. [The inverter compressor shall have a separate oil pump and an oil separator for each compressor that routes oil back to the compressor instead of through the discharge line.
5. Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.
6. Refrigerant circuit shall have a bypass valve between the suction and discharge refrigerant lines for low head pressure compressor starting and increased

compressor reliability. When there is a call for mechanical cooling the bypass valve shall open to equalizing the suction and discharge pressures. When pressures are equalized the bypass valve shall close and the compressor shall be allowed to start.

7. Each circuit shall be dehydrated and factory charged with R32 Refrigerant and oil.

L. ELECTRICAL

1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with the unit shall be number and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit. Each compressor and condenser fan motor shall be furnished with contactors and inherent thermal overload protection. Supply fan motors shall have contactors and external overload protection. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance.
2. A GFI receptacle shall be unit mounted that is field powered.
3. A single non-fused disconnect switch shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

M. CONTROLS

1. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested.
2. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate stand-alone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.

3. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
4. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
5. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to ensure that it is not lost during a power failure. There shall be one start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
6. The keypad interface shall allow convenient navigation and access to the commissioning functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
 - a) Supply speed control
 - b) All Refrigeration Capacities and control input signals.
 - c) Refrigeration alarm details.
 - d) Return air temperature.
 - e) Discharge air temperature
 - f) Outdoor air temperature.
 - g) Space air temperature.
 - h) Outdoor enthalpy, high/low.
 - i) Compressor suction temperature and pressure.
 - j) Compressor head pressure and temperature.
 - k) Expansion valve position.
 - l) Condenser fan speed.
 - m) Inverter compressor speed.
 - n) Dirty filter indication.
 - o) Airflow verification.
 - p) Cooling status.
 - q) Control temperature (Changeover).
 - r) Cooling status/capacity.
 - s) Unit status.
 - t) All time schedules.

- u) Previous alarms with time and date.
 - v) Optimal start.
 - w) System operating hours.
7. The user interaction with the keypad shall provide the following:
- a) Controls mode
 - b) Cooling and heating change-over temperature with deadband.
 - c) Cooling discharge air temperature (DAT).
 - d) Supply reset options.
 - e) Temperature alarm limits.
 - f) Lockout control for compressors.
 - g) Compressor interstage timers.
 - h) Night setback and setup space temperature.
 - i) Economizer changeover.
 - j) Currently time and date.
 - k) Tenant override time.
 - l) Occupied/unoccupied time schedule.
 - m) One event schedule.
 - n) Holiday dates and duration.
 - o) Adjustable set points.
 - p) Service mode.
8. If the unit is to be programmed with a night setback or setup function, an space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:
- a) Zone sensor with tenant override switch.
9. To increase the efficiency of the cooling system the DDC controller shall include a discharge air temperature reset program for part load operating conditions. The discharge air temperature shall be controlled between a minimum and a maximum discharge air temperature (DAT) based on one of the following inputs:
- a) Airflow.
 - b) Outside air temperature.
 - c) Space temperature.
 - d) Return air temperature.
 - e) External signal of 1-5 vdc.
 - f) External signal of 0-20 mA.
 - g) Network signal.
10. Units shall contain eight programmable input/output control ports to be controlled using the connected building automation system. These ports shall be input/output capable of utilizing the following signal types:
- a) mA signal (0-20 mA – Adjustable).
 - b) VDC (0-10 VDC – Adjustable).
 - c) 10k Thermistor.
 - d) Digital on/off.

N. A2L LEAK MITIGATION REFRIGERANT DETECTION SYSTEM (RDS) FOR COMPRESSORIZED ROOFTOP EQUIPMENT USING A2L REFRIGERANT.

1. Compressorized rooftop equipment using A2L refrigerant shall come equipped with a factory installed Refrigerant Detection System (RDS) in compliance with UL60335-2-40. The factory-installed unit controller will respond and control the unit to comply with UL60335-2-40 according to the alarm status of the refrigerant detection system. See the unit Operations Manual for a detailed sequence of operations.
2. The Refrigerant Detection System (RDS) shall consist of the following components:
 - a) Dedicated A2L Refrigerant Detection Control Board.
 - b) Refrigerant Sensor or Sensors. The number of sensors will vary based on the product and configuration as needed to comply with UL requirements.
3. Operation and Monitoring:
 - a) The refrigerant sensor or sensors communicate with the refrigerant detection control board. The refrigerant sensors detect the presence of the A2L refrigerant outside of the sealed refrigeration piping and communicate the levels to the refrigerant detection control board. The refrigerant detection controller communicates the RDS status to the factory-installed unit controller.
 - b) Alarm Communication: The unit controller will communicate RDS alarms based on the RDS status in the same way as any other alarm. Alarms are triggered by the following: 1) Refrigerant detected above 15% of the refrigerant lower flammability level (LFL); 2) Refrigerant Sensor Fault.
 - c) A customer relay is provided for the field to connect directly to the refrigerant detection control board as an alternative means to receive the above two alarm statuses.
 - d) A customer relay is provided for the field to connect directly to the refrigerant detection control board as an alternative means to receive the above two alarm statuses.
4. Factory unit wiring diagrams must show the refrigerant leak detection system wiring.

O. CURBS

1. A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2" x 4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install to NFPA 90A.
- C. Provide flexible duct connections on inlet and outlet from unit; refer to Section 23 3300.

3.2 START-UP

- A. The manufacturer shall submit to the Owner, a fully completed start-up and field test report for each unit. The test report shall be per manufacturer's standard format and list all test conditions, settings, performance data, outside conditions, and load.
- B. The contractors and manufacturer shall perform and document pre-functional checks of the air handling units including but not limited to fan start-up, alignment and adjustments, fan rotation, energy recovery wheel operation, damper and linkage operation.
- C. The contractor and manufacturer shall be responsible for participating in the functional checks of their equipment and shall assist, as requested, with the work carried out by the Testing and Balancing Agency, other HVAC equipment manufacturers and BAS contractor.
- D. The manufacturer shall support the testing by providing prompt on-site and factory support with adjustments, troubleshooting, modifications, spare parts, and performance data as needed.

END OF SECTION 237435

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SECTION 238101 - TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Unit heaters.
- B. Cabinet unit heaters.

1.2 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.3 WARRANTY

- A. See Division 1 - Closeout Submittals, for additional warranty requirements.

1.4 EXTRA MATERIALS

- A. Provide two sets of filters.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

- A. Manufacturers:
 - 1. Sterling Hydronics/Mestek Technology, Inc: www.sterlingheat.com.
 - 2. Trane Inc: www.trane.com.
 - 3. Rittling.
 - 4. Sigma
- B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Casing: 0.0478 inch steel with threaded pipe connections for hanger rods.
- D. Finish: Factory applied baked primer coat.

- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- F. Air Outlet: Adjustable pattern diffuser on projection models and two way louvers on horizontal throw models.
- G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models.
- H. Control: Local disconnect switch.
- I. Capacity: As scheduled, based on 65 degree F entering air temperature, 180 degree F average water temperature.

2.2 CABINET UNIT HEATERS

- A. Manufacturers:
 - 1. Sterling Hydronics/Mestek Technology, Inc: www.sterlingheat.com.
 - 2. Trane Inc: www.trane.com.
 - 3. Rittling.
 - 4. Sigma
- B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi and 220 degrees F.
- C. Cabinet: 0.0598 inch steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet.
- D. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.
- E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- G. Control: Multiple speed switch, factory wired, located in cabinet.
- H. Filter: Easily removed 1 inch thick permanent washable type, located to filter air before coil.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Do not damage equipment or finishes.
- C. Protection: Provide finished cabinet units with protective covers during balance of construction.
- D. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- E. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.

3.2 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- C. Install new filters.

END OF SECTION 238101

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SECTION 260100 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work specified in this section.

1.2 SCOPE OF PROJECT:

- A. Provide a complete and operating electrical installation in accordance with these specifications and accompanying contract drawings. This includes all required labor, materials, apparatus and supervision.
- B. Without limiting or restricting the volume of work and solely for the convenience of the Contractor, the work to be performed in general, comprises the following:
 - 1. Temporary lighting.
 - 2. Complete lighting and automatic lighting control systems in renovated portion of the building.
 - 3. Complete building power system in renovated portion of the building.
 - 4. Final connections to all equipment, unless otherwise noted.
 - 5. New addressable fire alarm and detection devices throughout the renovated portion of the building. Connect to existing fire alarm system.
 - 6. Control wiring for Division 23 equipment where shown on Division 26 documents.
 - 7. New Structured Cabling in renovated portion of the building.
 - 8. Extend existing access control system.
 - 9. Fire-proofing where required per code.
 - 10. Coordination with other contractors.

1.3 INTENT OF THIS SECTION:

- A. This Section is intended as a supplement to each of the following Sections of Division 26, 27, 28 ELECTRICAL.
- B. Consider each article of this Section as a part of each of the following Sections insofar as such requirements may be termed applicable.

1.4 TRUE INTENT:

- A. The Drawings and Specifications are intended to provide a complete and perfectly operating system. Therefore, it is specifically agreed and understood by the Contractor that anything, be it labor, material or equipment, which is not described in the Specifications or specifically shown on the Drawings, but is necessary for the operation and completion of a perfectly operating system, according to the true intent of the Specifications and Drawings and as interpreted by the architect, shall be furnished by

the Contractor as a part of his Contract, at no extra charge, as though it were specifically detailed and described.

1.5 DEFINITIONS:

- A. General - Basic Contract definitions are included in the Conditions of the Contract.
- B. Indicated - The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.
- C. Directed - Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.
- D. Approved - The term approved, when used in conjunction with the Architect's action on the Contractor's submittals, applications and requests, is limited to the Architects duties and responsibilities as stated in the Conditions of the Contract.
- E. Regulation - The term regulation includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. Furnish - The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation and similar operations.
- G. Install - The tem install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. Provide - The term provide means to furnish and install, complete and ready for the intended use.
- I. Contractor - The Contractor or Electrical Contractor - The term means the Contractor responsible for all work under this section.
- J. Installer - An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
 - 1. The term experienced, when used with the term installer, means having a minimum of five previous projects similar in size and scope to this project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
 - 2. Trades - Using terms such as carpentry is not intended to imply that certain

construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to tradespersons of the corresponding generic name.

3. Assigning Specialists - Certain Section of the Specifications require that specific construction activities are performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.
 - a. This requirement is not to be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

- K. Testing Agencies - A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere and to report on and, if required, to interpret results of those inspections or tests.

1.6 VISITS TO SITE:

- A. Attention is directed to the necessity for all the Electrical Contractor to visit the site and examine all conditions affecting the proper execution of this Contract. Submission of proposals shall be considered evidence that Contractors have visited and examined the site.
- B. Existing contours and topography as indicated, are believed to be reasonably correct, but are not guaranteed. Where conditions at project site do not agree exactly with conditions as indicated, Contractor shall assume all responsibility for said discrepancy.
- C. No extra payment will be allowed the Electrical Contractor for extra work caused by failure to visit, examine and clarify.

1.7 GENERAL:

- A. Throughout the Specifications, types of material are specified by manufacturer's name. Where more than one manufacturer is mentioned, catalog and specification data is given for a specific manufacturer. Equal material produced by other manufacturers listed is acceptable. Refer to SPECIAL REQUIREMENTS - Division 1 for substitution of materials.

1.8 RULES AND REGULATIONS

- A. Perform in accordance with the rules and regulations of the National Electric Code (NEC), International Building Code (IBC) and other Codes and Standards cited in this specification and the requirements of the Utility Companies serving this project.

- B. Certificates of Approval in triplicate, for rough and finished wiring from a Certified Inspection Service must be delivered to the Engineer before final payment can be authorized.
- C. Perform all work in accordance with the rules and regulations of the Pennsylvania Department of Labor and Industry, Federal Department of Labor (Occupational Safety and Health Administration) and any other national, state, or local authority having jurisdiction.
- D. Perform all Construction, design, fabrication, tests, rating, and installation in compliance with the regulations of all local, state or national agencies having jurisdiction over the project. Pay all costs involved in work necessary to comply with these regulations.
- E. The Contractor assumes all responsibility and liability for any code violations, damage or injury which occurs as a result of deviation from or a change to the requirements of these plans and specifications which has not been approved in writing by the Engineer.

1.9 SUBMITTAL OF SHOP DRAWINGS FOR REVIEW:

- A. Submit Shop Drawings in accordance with SUBMITTALS Division 1 and as indicated in subsequent Sections of this Division. Assume responsibility for quantities and correct mounting details. In addition, submit other shop drawings as may be requested by the Architect.
 - 1. Metal Clad Cable
 - 2. Building Wire
 - 3. Conduit
 - 4. Fittings
 - 5. Wireways
 - 6. Outlet Boxes
 - 7. Switches
 - 8. Receptacles
 - 9. Dry-type energy-efficient transformers
 - 10. Electronic Circuit Monitors
 - 11. Panelboards and Circuit Breakers
 - 12. Safety Switches and Fuses

1.10 DRAWINGS:

- A. The Electrical drawings are indicative of the general arrangements and approximate sizes and relative locations of principal materials to be provided. Drawings are diagrammatic and are a graphic representation of contract requirements to best available standards at the scale required. Provide certain items such as pull boxes, offsets to clear interferences, and supports which are not specifically shown but which are obviously needed to make the system complete and operable.
- B. Verify all grades, elevations, dimensions and clearances at the site.

- C. Electrical riser and schematic diagrams generally indicate wiring to be used in various systems. Provide all work shown on diagrams whether or not it is duplicated on the plans.
- D. All drawings and specifications pertaining to general construction, plumbing, HVAC, electrical and other work shall be carefully examined. Where physical interferences with his work occur because of his failure to coordinate with other trades, this Contractor shall rearrange his work at his own expense.

1.11 ENVIRONMENTAL CONDITIONS:

- A. Provide effective protection for all material and equipment against damage that may be caused by environmental conditions. Do no work when conditions or temperature in area or moisture on materials or substrates are not in accordance with material manufacturer's recommended conditions for installation.

1.12 PROTECTION:

- A. Provide effective protection against damage for all materials and equipment during shipment, and storage at the Project site. Cover all stored equipment to exclude dust and moisture. Place stored conduit on dunnage with appropriate weather cover and caps on exposed ends.
- B. After cabinets and boxes are installed, cover openings to prevent entrance of water and foreign materials. Close conduit openings with temporary metal or plastic caps, including those terminated in cabinets.
- C. Protect all rough and finished floors and finished surfaces from damage which may be caused by construction materials and methods. Protect floors with tarpaulins, chip pans and oil-proof floor coverings. Protect finished surfaces from welding and cutting splatters with baffles and asbestos splatter blankets. Protect finished surfaces from paint droppings, adhesive and other marring agents with drop cloths. Protect other surfaces with appropriate protective measures.

1.13 PRODUCT:

- A. Have materials delivered to site. Unload and store materials in allotted location, and protect from damage. Deliver materials to their point of installation.
- B. Deliver materials to Project site in manufacturer's original unopened containers with manufacturer's name and product identification clearly marked thereon.

1.14 COMPLIANCE WITH GENERAL STANDARDS AND REGULATIONS:

A. Provide equipment that is in conformity with these specifications and applicable requirements of the following:

1.	AASHTO	American Assoc. of State Highway and Transportation Officials
2.	ACI	American Concrete Institute
3.	AISC	American Institute of Steel Construction
4.	AISI	American Iron and Steel Institute
5.	ANSI	American National Standards Institute
6.	ASTM	American Society for Testing and Materials
7.	AWS	American Welding Society
8.	CBM	Certified Ballast Manufacturers Assoc.
9.	CRSI	Concrete Reinforcing Steel Institute
10.	EIA	Electronic Industries Assoc.
11.	ETL	ETL Testing Laboratories Inc.
12.	FM	Factory Mutual Research Assoc.
13.	ICEA	Insulated Cable Engineers Association, Inc.
14.	IEC	International Electrotechnical Commission
15.	IEEE	Institute of Electrical and Electronic Engineers
16.	IESNA	Illuminating Engineering Society of North America
17.	IMSA	International Municipal Signal Association
18.	LPI	Lighting Protection Institute
19.	NEC	National Electric Code
20.	NECA	National Electrical Contractors Association
21.	NEMA	National Electrical Manufacturers Association
22.	NETA	International Electrical Testing Association
23.	NFPA	National Fire Protection Association
24.	UL	Underwriters Laboratories, Inc

1.15 COMPLIANCE WITH FEDERAL GOVERNMENT AGENCIES

A. Names and titles of federal government standard - or Specification-producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard - Specification-producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to the date of the Contract Documents.

1.	ADA	Americans with Disabilities Act
2.	CFR	Code of Federal Regulations
3.	EPA	Environmental Protection Agency
4.	FAA	Federal Aviation Administration (US Dept. of Transportation)
5.	FCC	Federal Communication Commission
6.	FS	Federal Specification (from GSA); Specifications Unit (WFISIS)
7.	MIL	Military Standardization Documents (US Department of Defense) Naval Publications and Forms Center
8.	OSHA	Occupational Safety and Health Administration (US Department of Labor)
9.	REA	Rural Electrification Administration (US Department of Agriculture)

1.16 GUARANTEE:

- A. Each Contractor shall unconditionally guarantee in writing all materials, equipment, and workmanship for a period of one year from the date of substantial completion of the **final phase of the project**. The Contractor shall provide free service for all equipment involved in his Contract during this guarantee period.
- B. The guarantee shall include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- C. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.

PART 2 - PRODUCTS

2.1 Refer to Division 26 - ELECTRICAL

PART 3 - EXECUTION

3.1 LOCATION OF MATERIAL:

- A. Locate all lighting fixtures, power apparatus, conduit, outlets and other materials to result in proper operation of the building and to avoid conflicts with the work of other trades. Obtain required location information sufficiently in advance of installation time to allow uninterrupted progress of the work. Check layouts of equipment with shop drawings of all trades to determine roughing-in requirements. Do not scale drawings for exact locations. Exercise proper judgment to secure a neat arrangement of conduit, piping, ductwork and other material; and to overcome local interferences to best advantage of the Project.
- B. Where physical interferences cannot be resolved readily, consult with the Construction Manager and Architect and prepare dated, dimensioned drawings correcting the interferences. Obtain written approval of the Construction Manager and Architect for such changes and distribute the drawings to all interested parties as directed by the Construction Manager and Architect.
- C. In modular panel ceilings, locate lights, detectors and similar equipment as shown on reflected ceiling plan. Arrange ceiling outlets symmetrically. Verify locations of all floor outlets with Architect before roughing-in.
- D. Locate switches and other manually operated devices in a location easily accessible and convenient to operating personnel. If any such devices are mounted in a location deemed inaccessible or impractical, relocate devices at no increase in contract costs.

3.2 EARTHWORK:

- A. Provide all excavation, backfill, shoring and similar work as required for the installation of

the Work of this Division. Refer to the requirements of Excavation, Grading and Site Work, Section 33, and Earthwork, Division 2.

- B. Protect roots of live trees encountered in excavation.
- C. Where excavations at footings, foundations, and other structures are deeper than the angle of repose deemed adequate by Architect, backfill such excavations solidly with 3000 pound concrete.
- D. Remove and dispose of excess excavated materials as directed by the Construction Manager or Architect.

3.3 CHASES AND OPENINGS:

- A. Openings, recesses and chases will be provided in the building construction as described in SUPPLEMENTAL GENERAL CONDITIONS. Make detailed dimensioned drawings under Division 26 where required by Architect.

3.4 CUTTING AND PATCHING:

- A. Perform all cutting of existing building construction under Division 26 as required for installation of electrical work.
- B. Perform cutting carefully so as not to damage the structure or leave unsightly surfaces that cannot be covered with plates, escutcheons, or other normal concealing construction. Patch unsightly conditions resulting from cutting as directed by the Construction Manager or Architect. Engage competent mechanics for patching.

3.5 MOTOR STARTERS

- A. Furnish all manual motor starters, and mount where shown on drawings.
- B. Mount manual motor starters for roof fans in an accessible location inside the building to avoid affecting thermal devices by atmospheric conditions.
- C. In general, magnetic motor starters will be delivered to the site with the equipment they control.
 - 1. Starters furnished under Division 21, 22, and 23 will be delivered to the Electrical Contractor for installation and wiring. The Electrical Contractor shall mount the starters where shown on the Drawings, and provide power wiring to the starter, as well as power wiring from the starter to the motor. Control wiring will be provided under the HVAC Contract.
 - 2. Equipment furnished under other Divisions and under other contracts generally will not be combination type. Provide disconnects as required by the NEC within site of the controller and motor.

3. Check running current of each motor and verify correct size of overload elements, and fuses in combination starters. Notify Architect in writing of all overload elements and fuses incorrectly sized, so that corrective action can be initiated.
4. Prepare a typewritten list of all motors in the project, and submit to Architect for delivery to the Owner. Include the following information for each motor:
 - a. Function and nomenclature, as identified by the marking actually used in the field.
 - b. Physical location in the building.
 - c. Rated horsepower, voltage and phase.
 - d. Rated full load current.
 - e. Proper size of thermal overload element.
 - f. Mount all motor starters, except those factory mounted on equipment.

3.6 COLOR CODING OF WIRING

- A. Color code all wiring in accordance with the following table. In general, use factory colored insulation. Use colored vinyl tape for black insulation on cables No. 8 and larger. Apply pressure sensitive tape in half-lap serving for distance of 6" at cable terminations, in pull boxes, manholes, panels, and similar locations.
- | | | |
|---------------------|---------------|---------------|
| 1. Phase | 208/120 Volts | 480/277 Volts |
| 2. Phase "A" | Black | Brown |
| 3. Phase "B" | Blue | Orange |
| 4. Phase "C" | Red | Yellow |
| 5. Neutral | White | Gray |
| 6. Equipment ground | Green | Green |

3.7 PHASING

- A. Phase building load centers and panelboards "A", "B", "C" top to bottom and left to right. Identify the neutral, although it may be in different locations for different equipment.
- B. Connect transformers in all systems so that:
1. "A" Phase is terminated at "H1" connection.
 2. "B" Phase is terminated at "H2" connection.
 3. "C" Phase is terminated at "H3" connection.
 4. "X1" connection shall be the "A" Phase.
 5. "X2" connection shall be the "B" Phase.
 6. "X3" connection shall be the "C" Phase.
- C. Ascertain from Power Company phase identifications at the point of connection and thereafter carry out and maintain this consistent system of color coding, phase identification and positioning.
- D. Verify phase rotation after all terminations at equipment have been made, by producing a 1-2-3 rotation on a phase sequence meter when connected to "A", "B", and "C" phases. Make phase rotation compatible with existing distribution system.

3.8 GROUNDING RESISTANCE TEST:

- A. Provide grounding system resistance test to verify resistance. Maximum resistance shall be 5 ohms.
- B. Send final certified test reports and Certifications to Construction Manager for approval and transmittal to the Owner in accordance with SUBMITTALS, Division 1.

3.9 INSPECTION AND CERTIFICATION:

- A. Obtain and deliver a final Certificate of Approval from the applicable NEC inspection authority having jurisdiction. Make delivery to Construction Manager for transmittal to the Owner upon completion of the work and before final payment in accordance with PROJECT CLOSE-OUT, Division 1. Pay all charges made by the inspection authority and include their cost in the bid.

3.10 INSTALLATION:

- A. Install equipment in accordance with manufacturer's recommendations.

3.11 AS-BUILT DRAWINGS:

- A. During construction, the Contractor shall maintain a record set of installation prints. He shall record on these prints, all deviations from the Contract Drawings in pipe sizing, location, and details. The record set of installation prints shall be updated at the end of each month and shall be delivered to the Construction Manager and the Architect.
- B. At the completion of the work, the Contractor shall forward these prints to the Construction Manager and the Architect for incorporation into the final As-Built Drawings.

3.12 INSTRUCTION TO EMPLOYEES:

- A. At the completion of the work, and before final acceptance of the building by the Owner, each Contractor, together with the representatives of the manufacturers of the equipment installed by the Contractor, shall instruct the designated employees of the Owner in the care, adjustment, maintenance and operation of equipment installed by him. The instruction shall be video recorded and a copy of the recording turned over to the Owner for future reference.
- B. one hard and one electronic copies of factory maintenance schedules shall be furnished for each of equipment. Acceptance of materials and equipment is conditional upon receipts of maintenance manuals.
- C. A representative of the manufacturer of each piece of equipment shall inspect his respective pieces of equipment, make final adjustments, and put them in a satisfactory

working condition.

END OF SECTION 260100

SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition.

1.2 RELATED REQUIREMENTS

- A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.

- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 72 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify Owner before partially or completely disabling system.
 - 2. Notify local fire service.
- F. Existing Low-Voltage Systems: Maintain existing systems in service until new system is complete and ready for service. Disable systems only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 72 hours before partially or completely disabling systems.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 - 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
 - 2. PCB- and DEHP-containing lighting ballasts.
 - 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

- A. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION 260505

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Underground feeder and branch-circuit cable.
- C. Armored cable.
- D. Metal-clad cable.
- E. Variable-frequency drive cable.
- F. Wiring connectors.
- G. Electrical tape.
- H. Heat shrink tubing.
- I. Oxide inhibiting compound.
- J. Wire pulling lubricant.
- K. Cable ties.
- L. Firestop sleeves.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).

- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.
- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2020.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2022.
- H. FM 3971 - Fire Protective Coatings and Wraps for Grouped Cables; 2019.
- I. IEEE 383 - IEEE Standard for Qualifying Electric Cables and Splices for Nuclear Facilities; 2015.
- J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- K. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.
- L. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.
- M. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- N. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O. NFPA 79 - Electrical Standard for Industrial Machinery; 2021.
- P. UL 4 - Armored Cable; Current Edition, Including All Revisions.
- Q. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- R. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- S. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Most Recent Edition, Including All Revisions.
- T. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- U. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

- V. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- W. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- X. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.
- Y. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
- 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
- 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Field Quality Control Test Reports.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:
 - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
- G. Metal-clad cable is permitted only as follows:
 - 1. Where not otherwise restricted, may be used:

- a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
 - 1) Maximum Length: 6 feet.
- b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
 - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
- 2. In addition to other applicable restrictions, may not be used:
 - a. Where exposed to damage.
 - b. For damp, wet, or corrosive locations, unless provided with a PVC jacket listed as suitable for those locations.
 - c. For isolated ground circuits, unless provided with an additional isolated/insulated grounding conductor.
- H. Manufactured wiring systems are not permitted.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 260526.
- H. Conductors and Cables Installed in Cable Tray: Listed and labeled as suitable for cable tray use.
- I. Conductors and Cables Installed Where Exposed to Direct Rays of Sun: Listed and labeled as sunlight resistant.
- J. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- K. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.

2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 3. Tinned Copper Conductors: Comply with ASTM B33.
- L. Minimum Conductor Size:
1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
 2. Control Circuits: 14 AWG.
- M. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- N. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. Isolated Ground, All Systems: Green with yellow stripe.
 - e. Travelers for 3-Way and 4-Way Switching: Pink.
 - f. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
 - g. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:

1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. General Cable Technologies Corporation; _____:
www.generalcable.com/#sle.
 - d. Service Wire Co: www.servicewire.com/#sle.
 - e. Southwire Company: www.southwire.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:

1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:

1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Installed Underground: Type XHHW-2.

2.4 ARMORED CABLE

A. Manufacturers:

1. AFC Cable Systems Inc: www.afcweb.com/#sle.
2. Encore Wire Corporation: www.encorewire.com/#sle.
3. Southwire Company: www.southwire.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.

C. Conductor Stranding:

1. Size 10 AWG and Smaller: Solid.
2. Size 8 AWG and Larger: Stranded.

- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN.
- F. Grounding: Combination of interlocking armor and integral bonding wire.
- G. Armor: Steel, interlocked tape.

2.5 METAL-CLAD CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 - 2. Encore Wire Corporation: www.encorewire.com/#sle.
 - 3. Service Wire Co: www.servicewire.com/#sle.
 - 4. Southwire Company: www.southwire.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Conductor Stranding:
 - 1. Size 10 AWG and Smaller: Solid.
 - 2. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation: Type THHN/THWN-2.
- F. Grounding: Full-size integral equipment grounding conductor.
- G. Armor: Steel, interlocked tape.
- H. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.6 VARIABLE-FREQUENCY DRIVE CABLE

- A. Manufacturers:
 - 1. Service Wire Co; ServiceDrive: www.servicewire.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.

- C. Conductor Stranding: Stranded.
- D. Insulation Voltage Rating: 1000 V.
- E. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.
- F. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.
- G. Provide metallic shielding.
- H. Jacket: PVC or Chlorinated Polyethylene (CPE).

2.7 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 260526.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 - 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors where connectors are required.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.

1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

- H. Mechanical Connectors: Provide bolted type or set-screw type.

1. Manufacturers:
 - a. Burndy LLC; _____: www.burndy.com/#sle.
 - b. IlSCO: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.

1. Manufacturers:
 - a. Burndy LLC; _____: www.burndy.com/#sle.
 - b. IlSCO: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.8 ACCESSORIES

- A. Electrical Tape:

1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Plymouth Rubber Europa: www.plymouthrubber.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.

5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Burndy LLC; _____: www.burndy.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
1. Manufacturers:
 - a. Burndy LLC; _____: www.burndy.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. IlSCO: www.ilsco.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Wire Pulling Lubricant:
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. American Polywater Corporation: www.polywater.com/#sle.
 - c. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Listed and labeled as complying with UL 267.
 3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 4. Suitable for use at installation temperature.
 5. Products:
 - a. American Polywater Corporation; Polywater J Cable Pulling Lubricant: www.polywater.com/#sle.
 - b. American Polywater Corporation; Polywater LZ Cable Pulling Lubricant: www.polywater.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- E. Cable Ties: Material and tensile strength rating suitable for application.

- F. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.
1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- G. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- H. Fire-Protective Coating for Electrical Conductors and Cables: Field-applied, intumescent or ablative coating designed to prevent ignition and propagation of fire along thermoplastic-insulated conductors and cables.
1. Pass flammability tests of one of the following:
 - a. ASTM E84, Class A; maximum flame spread index of 25.
 - b. FM 3971.
 - c. IEEE 383.
 2. Products:
 - a. Vimasco Corporation; CharCoat CC Cable Coating: www.charcoat.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:

1. Unless dimensioned, circuit routing indicated is diagrammatic.
2. When circuit destination is indicated without specific routing, determine exact routing required.
3. Arrange circuiting to minimize splices.
4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
9. Provide oversized neutral/grounded conductors where indicated and as specified below.
 - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
 - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.

- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install armored cable (Type AC) in accordance with NECA 120.
- E. Install metal-clad cable (Type MC) in accordance with NECA 120.

- F. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 - 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- I. Terminate cables using suitable fittings.
 - 1. Armored Cable (Type AC):
 - a. Use listed fittings and anti-short, insulating bushings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
 - 2. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- J. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.
- K. Install conductors with a minimum of 12 inches of slack at each outlet.
- L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- N. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 3. Wet Locations: Use heat shrink tubing.
- P. Insulate ends of spare conductors using vinyl insulating electrical tape.
- Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- R. Identify conductors and cables in accordance with Section 260553.
- S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- T. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables.
- E. Provide infrared imaging of major components at typical load.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground enhancement material.
- G. Ground access wells.

1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
 - 1. Includes oxide inhibiting compound.
- B. Section 260536 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.3 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2017.
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.

- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 99 - Health Care Facilities Code; 2021, with Amendment.
- G. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2023.
- H. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Field quality control test reports.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:

1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

F. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
5. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 20 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - d. Provide ground enhancement material around electrode.
 - e. Provide ground access well for each electrode.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
 8. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.
- G. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
 2. Provide equipment grounding conductor routed with supply conductors.
 3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
- I. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
 - c. Generators, when neutral is switched in the transfer switch.
 2. Provide grounding electrode conductor to connect derived system grounded conductor to common grounding electrode conductor ground riser. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.

4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
 - c. Metal process piping.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame.
10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.
12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.

- K. Isolated Ground System:
 - 1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
 - 2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
 - 3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.
- L. Communications Systems Grounding and Bonding:
 - 1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 - 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- M. Cable Tray Systems: Also comply with Section 260536.
- N. Pole-Mounted Luminaires: Also comply with Section 265600.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors or exothermic welded connections for accessible connections.
4. Manufacturers - Mechanical and Compression Connectors:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Burndy LLC; _____: www.burndy.com/#sle.
 - c. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - d. nVent ERICO; _____: www.nvent.com/#sle.
 - e. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
5. Manufacturers - Exothermic Welded Connections:
 - a. Burndy LLC; _____: www.burndy.com/#sle.
 - b. nVent ERICO; Cadweld: www.nvent.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - c. nVent ERICO; _____: www.nvent.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Galvan Industries, Inc; _____: www.galvanelectrical.com/#sle.
 - c. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - d. nVent ERICO; _____: www.nvent.com/#sle.

- e. Substitutions: See Section 016000 - Product Requirements.
- F. Ground Enhancement Material:
 - 1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
 - 2. Resistivity: Not more than 20 ohm-cm in final installed form.
 - 3. Manufacturers:
 - a. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - b. nVent ERICO; GEM: www.nvent.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- G. Ground Access Wells:
 - 1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
 - 2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 - a. Round Wells: Not less than 8 inches in diameter.
 - b. Rectangular Wells: Not less than 12 by 12 inches.
 - 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
 - 4. Cover: Factory-identified by permanent means with word "GROUND".
 - 5. Manufacturers:
 - a. allG Fabrication; _____: www.allgfab.com/#sle.
 - b. Harger Lightning & Grounding; _____: www.harger.com/#sle.
 - c. nVent ERICO; _____: www.nvent.com/#sle.
 - d. thermOweld, subsidiary of Continental Industries; division of Burndy LLC; _____: www.thermoweld.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- H. Oxide Inhibiting Compound: Comply with Section 260519.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
 - 2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 055000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.

4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 033000.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

1.6 QUALITY ASSURANCE

- A. Maintain at project site one copy of each referenced document that prescribes execution requirements.
- B. Installer Qualifications for Field Welding: See Section 055000.
- C. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.

3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of 2. Include consideration for vibration, equipment operation, and shock loads where applicable.
 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. nVent; Caddy: www.nvent.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
 2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 3. Conduit Clamps: Bolted type unless otherwise indicated.
 4. Products:
 - a. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
 - b. Gripple, Inc; Fast Trak: www.gripple.com/#sle.
 - c. Gripple, Inc; Universal Clamp (Threaded): www.gripple.com/#sle.
 - d. Gripple, Inc; Low Profile Bracket Kits: www.gripple.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 - e. nVent; Caddy: www.nvent.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
- D. Metal Channel/Strut Framing Systems:
1. Manufacturers:
 - a. ABB: www.electrification.us.abb.com/#sle.

- b. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - c. Eaton Corporation: www.eaton.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - e. Source Limitations: Furnish channel/strut and associated fittings, accessories, and hardware produced by single manufacturer.
 2. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 3. Comply with MFMA-4.
 4. Channel/Strut Used as Raceway, Where Indicated: Listed and labeled as complying with UL 5B.
 5. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 6. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 7. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Busway Supports: 1/2-inch diameter.
 - c. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - d. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - e. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - f. Outlet Boxes: 1/4-inch diameter.
 - g. Luminaires: 1/4-inch diameter.
- F. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
1. Manufacturers:
 - a. Atkore International Inc; Unistrut: www.unistrut.us/#sle.
 - b. Eaton Corporation: www.eaton.com/#sle.
 - c. nVent; Caddy: www.nvent.com/#sle.
 - d. PHP Systems/Design: www.phpsd.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring attachment to roof structure and not penetrating roofing assembly, with support fixtures as specified.
 3. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 5. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

G. Anchors and Fasteners:

1. Manufacturers - Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
 - d. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Hollow Masonry: Use toggle bolts.
7. Hollow Stud Walls: Use toggle bolts.
8. Steel: Use beam clamps, machine bolts, or welded threaded studs.
9. Sheet Metal: Use sheet metal screws.
10. Wood: Use wood screws.
11. Plastic and lead anchors are not permitted.
12. Powder-actuated fasteners are not permitted.
13. Hammer-driven anchors and fasteners are not permitted.
14. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.
 - d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
15. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.

- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Unless otherwise indicated, mount floor-mounted equipment on properly sized concrete pad 4 inches in height; see Section 033000.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- J. Secure fasteners in accordance with manufacturer's recommended torque settings.
- K. Remove temporary supports.
- L. Identify independent electrical component support wires above accessible ceilings, where permitted, with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

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SECTION 260533.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Stainless steel rigid metal conduit (RMC).
- C. Galvanized steel intermediate metal conduit (IMC).
- D. Stainless steel intermediate metal conduit (IMC).
- E. PVC-coated galvanized steel rigid metal conduit (RMC).
- F. Flexible metal conduit (FMC).
- G. Liquidtight flexible metal conduit (LFMC).
- H. Galvanized steel electrical metallic tubing (EMT).
- I. Rigid polyvinyl chloride (PVC) conduit.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 078400 - Firestopping.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- D. Section 260529 - Hangers and Supports for Electrical Systems.
- E. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
- F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.

- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2018.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2017.
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- H. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit; 2018.
- I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.
- J. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.
- K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- M. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- N. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- O. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.
- P. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- Q. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- R. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- S. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- T. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
- U. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
- V. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground and conduits 2-inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use rigid PVC conduit.
2. Exterior, Direct-Buried: Use rigid PVC conduit.
3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), or stainless steel intermediate metal conduit (IMC) where emerging from underground.
5. Where rigid polyvinyl (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use PVC-coated galvanized steel rigid metal conduit (RMC) elbows for bends.
6. Where galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) is installed in direct contact with earth, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection.

D. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.
2. Within Slab Above Ground: Not permitted.
3. Within Concrete Walls Above Ground: Use rigid PVC conduit.
4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC) where emerging from concrete.

E. Concealed Within Masonry Walls: Use galvanized steel electrical metallic tubing (EMT).

F. Concealed Within Hollow Stud Walls: Use galvanized steel electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC) or stainless steel rigid metal conduit (RMC).

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel electrical metallic tubing (EMT).

1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
 - b. Where exposed below 20 feet in warehouse areas.

- K. Exposed, Interior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).
 - 1. Locations subject to severe physical damage include, but are not limited to:
 - a. High traffic industrial and warehouse areas where exposed below 8 feet, except within electrical and communication rooms or closets.
 - b. Where exposed below 20 feet in industrial manufacturing areas.
- L. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC).
- M. Exposed, Exterior, Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC) or stainless steel rigid metal conduit (RMC).
 - 1. Exterior locations subject to severe physical damage include, but are not limited to:
 - a. Where exposed to vehicular traffic below 20 feet.
- N. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit (RMC) or stainless steel rigid metal conduit (RMC).
- O. Corrosive Locations Above Ground: Use stainless steel rigid metal conduit (RMC) or PVC-coated galvanized steel rigid metal conduit (RMC).
 - 1. Corrosive locations include, but are not limited to:
 - a. Cooling towers.
 - b. Electroplating operations.
 - c. Swimming pools and associated equipment areas.
 - d. Wastewater treatment facilities.
 - e. Marine environments.
 - f. Chemical storage areas.
- P. Hazardous/Classified Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit (RMC).
- Q. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
 - 1. Maximum Length: 6 feet.
- R. Flexible Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit (FMC).
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).

3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.

S. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC).

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Fittings for Grounding and Bonding: See Section 260526 for additional requirements.
- D. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 1. Branch Circuits: 3/4-inch trade size.
 2. Branch Circuit Homeruns: 3/4-inch trade size.
 3. Control Circuits: 3/4-inch trade size.
 4. Flexible Connections to Luminaires: 3/8-inch trade size.
 5. Underground, Interior: 3/4-inch trade size.
 6. Underground, Exterior: 1-inch trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 2. Nucor Tubular Products: www.nucortubular.com/#sle.
 3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings Inc: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use steel or malleable iron.
 - a. Where not subject to severe corrosive influence, stainless steel or aluminum fittings may be used.
 - b. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
2. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
3. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.

1. Material: Type 304 or 316 stainless steel.

C. Fittings:

1. Manufacturers:
 - a. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
 - b. Eaton: www.eaton.com/#sle.
 - c. Gibson Stainless & Specialty Inc: www.gibsonstainless.com/#sle.
 - d. Patriot Industries, a division of Patriot Aluminum Products LLC: www.patriotsas.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.

4. Material: Use stainless steel with corrosion resistance equivalent to conduit.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.5 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:

1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
2. Nucor Tubular Products: www.nucortubular.com/#sle.
3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

C. Fittings:

1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use steel or malleable iron.
 - a. Where not subject to severe corrosive influence, stainless steel or aluminum fittings may be used.
 - b. Do not use die cast zinc fittings.
5. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.6 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Manufacturers:

1. Calbrite, a division of Atkore International: www.calbrite.com/#sle.
2. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

1. Material: Type 304 or 316 stainless steel.

C. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
2. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
3. Material: Use stainless steel with corrosion resistance equivalent to conduit.
4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.7 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. ABB; Ocal: www.electrification.us.abb.com/#sle.
2. Calbond, a division of Atkore International www.calbond.com/#sle
3. Robroy Industries: www.robroy.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

C. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.

D. Interior Coating: Urethane, minimum thickness of 2 mil, 0.002 inch.

E. PVC-Coated Boxes and Fittings:

1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
3. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.
4. Material: Use steel or malleable iron.
5. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
6. Interior Coating: Urethane, minimum thickness of 2 mil, 0.002 inch.

F. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.8 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
2. Electri-Flex Company: www.electriflex.com/#sle.

3. International Metal Hose: www.metalhose.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- C. Fittings:
1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.9 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
1. AFC Cable Systems, a division of Atkore International: www.afcweb.com/#sle.
 2. Electri-Flex Company: www.electriflex.com/#sle.
 3. International Metal Hose: www.metalhose.com/#sle.
 4. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.

2.10 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 2. Nucor Tubular Products: www.nucortubular/#sle.

3. Western Tube, a division of Zekelman Industries: www.westerntube.com/#sle.
 4. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
1. Manufacturers:
 - a. ABB; T&B: www.electrification.us.abb.com/#sle.
 - b. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 - c. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - d. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 3. Material: Use steel or malleable iron.
 - a. Do not use die cast zinc fittings.
 4. Connectors and Couplings: Use compression/gland type.
 - a. Do not use indenter type connectors and couplings.
 5. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.
 6. Embedded Within Concrete, Where Permitted: Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.11 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
1. ABB; Carlon: www.carlon.com/#sle.
 2. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 3. Cantex Inc: www.cantexinc.com/#sle.
 4. Heritage Plastics, a division of Atkore International: www.heritageplastics.com/#sle.
 5. JM Eagle: www.jmeagle.com/#sle.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.12 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- E. Foam Conduit Sealant:
 - 1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
 - 2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 - 3. Rated to hold minimum of 10 ft water head pressure.
 - 4. Products:
 - a. American Polywater Corporation; Polywater AFT Foam Duct Sealant: www.polywater.com/#sle.
 - b. American Polywater Corporation; Polywater FST Foam Duct Sealant: www.polywater.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- F. Conduit Mechanical Seals:
 - 1. Listed as complying with UL 514B.
 - 2. Specifically designed for sealing conduit openings against water, moisture, gases, and dust.
 - 3. Suitable for sealing around conductors/cables to be installed.
 - 4. Products:
 - a. American Polywater Corporation; PHRD SG Mechanical Seals: www.polywater-haufftechnik.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- G. Sealing Compound for Hazardous/Classified Location Sealing Fittings: Listed for use with particular fittings to be installed.
- H. Sealing Systems for Concrete Penetrations:
 - 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 - 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
 - 3. Products:

- a. American Polywater Corporation; PZVR Cement-Coated Concrete Wall Sleeves: www.polywater-haufftechnik.com/#sle.
 - b. American Polywater Corporation; PHSD Mechanical Seals: www.polywater-haufftechnik.com/#sle.
 - c. American Polywater Corporation; PHSI 150 Varia Double Wall Inserts: www.polywater-haufftechnik.com/#sle.
 - d. American Polywater Corporation; PGKD Modular Seals: www.polywater-haufftechnik.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- I. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- 1. Products:
 - a. Menzies Metal Products; Electrical Roof Stack and Cap: www.menzies-metal.com/#sle.
 - b. Menzies Metal Products; Electrical Retro Box: www.menzies-metal.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- J. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
- 1. Products:
 - a. Quickflash Weatherproofing Products, Inc: www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- K. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.
- 1. Products:
 - a. HoldRite, a brand of Reliance Worldwide Corporation; HydroFlame Pro Series/HydroFlame Custom Built: www.holdrite.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- L. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.
- 1. Products:
 - a. Advance Products & Systems, LLC; Duct Bank Spacers: www.apsonline.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

- M. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for casing and conduit/duct arrangement to be installed.

1. Products:

- a. Advance Products & Systems, LLC; Bore Spacers:
www.apsonline.com/#sle.
- b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by manufacturer.
- F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- G. Conduit Routing:
 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 2. When conduit destination is indicated without specific routing, determine exact routing required.
 3. Conceal conduits unless specifically indicated to be exposed.
 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 5. Unless otherwise approved, do not route exposed conduits:

- a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
 9. Arrange conduit to provide no more than 150 feet between pull points.
 10. Route conduits above water and drain piping where possible.
 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 14. Group parallel conduits in same area on common rack.

H. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
2. Provide required vibration isolation and/or seismic controls; see Section 260548.
3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
4. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
5. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
6. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
7. Use conduit clamp to support single conduit from beam clamp or threaded rod.
8. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
9. Use nonpenetrating rooftop supports to support conduits routed across rooftops, where approved.
10. Use of spring steel conduit clips for support of conduits is not permitted.
11. Use of wire for support of conduits is not permitted.

12. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.

I. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
7. Secure joints and connections to provide mechanical strength and electrical continuity.

J. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.

K. Underground Installation:

1. Provide trenching and backfilling; see Section 312316.13.
2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 24 inches.
 - b. Under Slab on Grade: 12 inches to bottom of slab.
3. Provide underground warning tape along entire conduit length; see Section 260553.

- L. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
 - 1. Secure conduits to prevent floating or movement during pouring of concrete.
- M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide minimum concrete cover of 3 inches on all sides unless otherwise indicated; see Section 033000.
- N. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 - 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 - 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 - 3. Where conduits are subject to earth movement by settlement or frost.
- O. Conduit Sealing:
 - 1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 - 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
 - c. Where conduits penetrate coolers or freezers.
 - 3. Where conduits cross boundaries of hazardous/classified locations, provide identified/listed sealing fittings or conduit mechanical seals as approved by authorities having jurisdiction; locate as indicated or in accordance with NFPA 70.
- P. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- Q. Provide grounding and bonding; see Section 260526.
- R. Identify conduits; see Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.
- E. Floor boxes.
- F. Underground boxes/enclosures.
- G. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 083100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260533.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- E. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
- F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 262726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.
 - 3. Poke-through assemblies.
 - 4. Additional requirements for locating boxes for wiring devices.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
- F. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports; 2013 (Reaffirmed 2020).
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. SCTE 77 - Specifications for Underground Enclosure Integrity; 2017.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- L. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- M. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
- N. UL 1203 - Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.

4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 016000 - Product Requirements, for additional provisions.
 2. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
4. Use nonmetallic boxes where exposed rigid PVC conduit is used.
5. Use suitable concrete type boxes where flush-mounted in concrete.
6. Use suitable masonry type boxes where flush-mounted in masonry walls.
7. Use raised covers suitable for the type of wall construction and device configuration where required.
8. Use shallow boxes where required by the type of wall construction.
9. Do not use "through-wall" boxes designed for access from both sides of wall.
10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
12. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
13. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
14. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
15. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.

- b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
- c. Ceiling Outlets: 4 inch octagonal or square by 2-1/8 inch deep (100 by 54 mm) trade size.
- 16. Wall Plates: Comply with Section 262726.
- 17. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
 - b. Hubbell Incorporated; Bell Products; _____: www.hubbell-rtb.com/#sle.
 - c. Hubbell Incorporated; RACO Products; _____: www.hubbell-rtb.com/#sle.
 - d. O-Z/Gedney, a brand of Emerson Electric Co; _____: www.emerson.com/#sle.
 - e. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
 - 1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 - 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 - 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 - 4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
 - a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
 - b. Back Panels: Painted steel, removable.
 - c. Terminal Blocks: Provide voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
 - 5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 - 6. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products; _____: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products; _____: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.

1. Manufacturers:
 - a. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- E. Boxes for Hazardous (Classified) Locations: Listed and labeled as complying with UL 1203 for the classification of the installed location.
 1. Manufacturers:
 - a. Appleton, a brand of Emerson Electric Co; _____: www.emerson.com/#sle.
 - b. Cooper Crouse-Hinds, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
 - c. Hubbell Incorporated; Killark Products; _____: www.hubbell-killark.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- F. Floor Boxes:
 1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 262726; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 2. Use cast iron floor boxes within slab on grade.
 3. Use sheet-steel or cast iron floor boxes within slab above grade.
 4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
 5. Manufacturer: Same as manufacturer of floor box service fittings.
- G. Underground Boxes/Enclosures:
 1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
 2. Size: As indicated on drawings.
 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
 4. Provide logo on cover to indicate type of service.
 5. Applications:
 - a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 8 load rating.
 - b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77, Tier 22 load rating.
 - c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
 6. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
 - a. Manufacturers:

- 1) Hubbell Incorporated; Quazite Products; _____:
www.hubbellpowersystems.com/#sle.
 - 2) MacLean Highline; _____: www.macleanhighline.com/#sle.
 - 3) Oldcastle Precast, Inc; _____:
www.oldcastleprecast.com/#sle.
 - 4) Substitutions: See Section 016000 - Product Requirements.
- b. Combination fiberglass/polymer concrete boxes/enclosures are acceptable.
- c. Product(s):
- 1) MacLean Highline PHA Series: Straight wall, all-polymer concrete splice box/pull box; available Tier 8, Tier 15, and Tier 22 load ratings.
 - 2) MacLean Highline CHA Series: Fiberglass/polymer concrete splice box/pull box; available Tier 8 and Tier 15 load ratings.
 - 3) MacLean Highline CVA Series: Fiberglass/polymer concrete splice vault; available Tier 8, Tier 15, and Tier 22 load ratings.

2.2 ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.
1. Manufacturers:
- a. Quickflash Weatherproofing Products, Inc:
www.quickflashproducts.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
 - 2. Unless dimensioned, box locations indicated are approximate.
 - 3. Locate boxes so that wall plates do not span different building finishes.
 - 4. Locate boxes so that wall plates do not cross masonry joints.
 - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 - 9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.13.
 - 10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
 - 2. Provide required seismic controls in accordance with Section 260548.

3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 4. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- L. Floor-Mounted Cabinets: Mount on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.
- M. Install boxes as required to preserve insulation integrity.
- N. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.
- O. Underground Boxes/Enclosures:
1. Install enclosure on gravel base, minimum 6 inches deep.
 2. Flush-mount enclosures located in concrete or paved areas.
 3. Mount enclosures located in landscaped areas with top at 1 inch above finished grade.
 4. Provide cast-in-place concrete collar constructed in accordance with Section 033000, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.
 5. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.
- P. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- R. Close unused box openings.
- S. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

- T. Provide grounding and bonding in accordance with Section 260526.
- U. Identify boxes in accordance with Section 260553.

3.3 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 260533.16

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 260536 - Cable Trays for Electrical Systems: Additional identification requirements for cable tray systems.
- C. Section 260573 - Power System Studies: Arc flash hazard warning labels.
- D. Section 262300 - Low-Voltage Switchgear: Factory-installed mimic bus.
- E. Section 262726 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.
- F. Section 271000 - Structured Cabling: Identification for communications cabling and devices.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. NFPA 70E - Standard for Electrical Safety in the Workplace; 2021.
- C. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:

1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.

- 2) Identify voltage and phase.
- 3) Identify power source and circuit number. Include location when not within sight of equipment.
- 4) Use identification nameplate to identify main overcurrent protective device.
- 5) Use identification nameplate to identify load(s) served for each branch device.
- b. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
- c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify load(s) served. Include location when not within sight of equipment.
- d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
- e. Time Switches:
 - 1) Identify load(s) served and associated circuits controlled. Include location.
- f. Enclosed Contactors:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
 - 4) Identify coil voltage.
 - 5) Identify load(s) and associated circuits controlled. Include location.
- g. Transfer Switches:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.

- 3) Identify load(s) served. Include location when not within sight of equipment.
 - 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
 - h. Electricity Meters:
 - 1) Identify load(s) metered.
2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
3. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
6. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
7. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
8. Use identification label on inside of door at each fused switch to identify required NEMA fuse class and size.
9. Use identification label on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
10. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
11. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances.
 - a. Field-Painted Floor Markings: Yellow stripes, 3 inches wide
12. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.
 - f. Panelboards.

13. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 3.5 by 5 inches.
 - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
 - c. Service Equipment: Include the following information in accordance with NFPA 70.
 - 1) Nominal system voltage.
 - 2) Available fault current.
 - 3) Clearing time of service overcurrent protective device(s).
 - 4) Date label applied.
14. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
15. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
16. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
17. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.

C. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Identification for Communications Conductors and Cables: Comply with Section 271000.
3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.

- c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
- d. In cable tray, at maximum intervals of 20 feet.
- 5. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
- 6. Use underground warning tape to identify direct buried cables.

D. Identification for Raceways:

- 1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
- 2. Use voltage markers, color-coded bands, or factory-painted conduits to identify systems other than normal power system for accessible conduits.
 - a. Maximum Intervals: 20 feet.
 - b. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
 - 1) Field-Painting:
 - 2) Vinyl Color Coding Electrical Tape: Comply with Section 260519.
 - c. Color Code:
 - 1) Emergency Power System:
 - (a) Life Safety Branch: Red.
 - (b) Equipment Branch: Green.
 - 2) Fire Alarm System: Red.
- 3. Use identification labels or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
- 4. Use identification labels or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
- 5. Use underground warning tape to identify underground raceways.
- 6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.

E. Identification for Cable Tray: Comply with Section 260536.

F. Identification for Boxes:

- 1. Use voltage markers to identify highest voltage present.
- 2. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted
 - b. For exposed boxes in public areas, do not color code.
- 3. Use identification labels to identify circuits enclosed.
 - a. For exposed boxes in public areas, provide identification on inside face of cover.
- 4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".

G. Identification for Devices:

1. Identification for Communications Devices: Comply with Section 271000.
2. Wiring Device and Wallplate Finishes: Comply with Section 262726.
3. Use identification label to identify fire alarm system devices.
 - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
5. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
6. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

H. Identification for Luminaires:

1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products; _____: www.seton.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Manufacturers:
 - a. Brady Corporation; _____: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend:
 - a. System designation where applicable:
 - 1) Emergency Power System: Identify with text "EMERGENCY".
 - 2) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
 - d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
 - c. Fire Alarm System: White text on red background.

D. Format for General Information and Operating Instructions:

1. Minimum Size: 1 inch by 2.5 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/4 inch.
5. Color: Black text on white background unless otherwise indicated.
 - a. Exceptions:
 - 1) Provide white text on red background for general information or operational instructions for emergency systems.
 - 2) Provide white text on red background for general information or operational instructions for fire alarm systems.

E. Format for Caution and Warning Messages:

1. Minimum Size: 2 inches by 4 inches.
2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 1/2 inch.
5. Color: Black text on yellow background unless otherwise indicated.

F. Format for Receptacle Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Power source and circuit number or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

G. Format for Control Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Load controlled or other designation indicated.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Black text on clear background.

H. Format for Fire Alarm Device Identification:

1. Minimum Size: 3/8 inch by 1.5 inches.
2. Legend: Designation indicated and device zone or address.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height: 3/16 inch.
5. Color: Red text on white background.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:

1. Brady Corporation; _____: www.bradyid.com/#sle.
2. HellermannTyton; _____: www.hellermannntyton.com/#sle.
3. Panduit Corp: www.panduit.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
 - 1. Do not use handwritten text.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

- A. Manufacturers:
 - 1. Brady Corporation; _____: www.bradyid.com/#sle.
 - 2. Brimar Industries, Inc: www.brimar.com/#sle.
 - 3. Seton Identification Products; _____: www.seton.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- D. Minimum Size:
 - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- E. Legend:
 - 1. Markers for Voltage Identification: Highest voltage present.
 - 2. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
 - b. Other Systems: Type of service.
- F. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:

1. Brady Corporation; _____: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Seton Identification Products; _____: www.seton.com/#sle.
4. Substitutions: See Section 016000 - Product Requirements.

B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color:

1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 FLOOR MARKING TAPE

A. Manufacturers:

1. Brady Corporation; _____: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Insite Solutions, LLC; _____: www.stop-painting.com/#sle.
4. Seton Identification Products; _____: www.seton.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.

2.7 WARNING SIGNS AND LABELS

A. Manufacturers:

1. Brimar Industries, Inc: www.brimar.com/#sle.
2. Clarion Safety Systems, LLC; _____: www.clarionsafety.com/#sle.
3. Insite Solutions, LLC; _____: www.stop-painting.com/#sle.
4. Seton Identification Products; _____: www.seton.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

C. Warning Signs:

1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
3. Minimum Size: 7 by 10 inches unless otherwise indicated.

D. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

E. Floor Signs:

1. Materials: Use factory preprinted, self-adhesive vinyl, polyester, or rubber labels with protective overlamine; removable.
2. Minimum Size: 17-inch diameter unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 1. Surface-Mounted Equipment: Enclosure front.
 2. Flush-Mounted Equipment: Inside of equipment door.
 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Conduits: Legible from the floor.

8. Boxes: Outside face of cover.
 9. Conductors and Cables: Legible from the point of access.
 10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

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SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Occupancy sensors.
- B. Outdoor photo controls.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260537 - Boxes.
- C. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 262726 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, fan speed controllers, and wall plates.
- E. Section 265100 - Interior Lighting.
- F. Section 265200 – Gymnasium Theatrical Lighting.

1.3 REFERENCE STANDARDS

- A. ANSI C136.24 - American National Standard for Roadway and Area Lighting Equipment - Nonlocking (Button) Type Photocontrols; 2004 (R2010).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- D. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 773 - Plug-in Locking Type Photocontrols for Use with Area Lighting; Current Edition, Including All Revisions.

- G. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.
- H. UL 916 - Energy Management Equipment; Current Edition, Including All Revisions.
- I. UL 917 - Clock-Operated Switches; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.

1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.

C. Shop Drawings:

1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.

D. Field Quality Control Reports.

- E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Include detailed information on device programming and setup.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
- H. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for all occupancy sensors.

PART 2 - PRODUCTS

2.1 ALL LIGHTING CONTROL DEVICES

- A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.
- C. Products for Switching of Electronic Fluorescent Ballasts: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.2 OCCUPANCY SENSORS

- A. Manufacturers:
 - 1. Hubbell Building Automation, Inc: www.hubbellautomation.com
 - 2. WattStopper: www.wattstopper.com.
 - 3. Leviton: www.leviton.com
 - 4. Acuity
 - 5. Lutron
 - 6. Substitutions: See Section 016000 - Product Requirements.
 - 7. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- B. All Occupancy Sensors:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
 - b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.
 - c. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
 - 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 - 4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.

5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
7. Turn-Off Delay: Field adjustable, up to a maximum time delay setting of not less than 15 minutes and not more than 30 minutes.
8. Sensitivity: Field adjustable.
9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
10. Integral Photocell: For field selectable and adjustable inhibition of automatic turn-on of load when ambient lighting is above the selected level.
11. Compatibility: Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
12. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on the drawings.
13. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

C. Wall Switch Occupancy Sensors:

1. All Wall Switch Occupancy Sensors:
 - a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
 - b. Unless otherwise indicated or required to control the load indicated on the drawings, provide line voltage units with self-contained relay.
 - c. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
 - d. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
 - e. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
2. Passive Infrared (PIR) Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
3. Ultrasonic Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 400 square feet.
4. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.

D. Ceiling Mounted Occupancy Sensors:

1. All Ceiling Mounted Occupancy Sensors:
 - a. Description: Low profile occupancy sensors designed for ceiling installation.
 - b. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - c. Provide field selectable setting for disabling LED motion detector visual indicator.
 - d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
 - e. Finish: White unless otherwise indicated.
2. Passive Infrared (PIR) Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
3. Ultrasonic Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 500 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 2,000 square feet at a mounting height of 9 feet.
4. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
 - b. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.

E. Power Packs for Low Voltage Occupancy Sensors:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.
2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating: As required to control the load indicated on the drawings.

2.3 OUTDOOR PHOTO CONTROLS

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com.
2. Paragon, a brand of Invensys Controls: www.invensyscontrols.com.
3. Tork, a division of NSI Industries LLC: www.tork.com.

4. Substitutions: See Section 016000 - Product Requirements.
5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Stem-Mounted Outdoor Photo Controls:

1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
2. Housing: Weatherproof, impact resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Provide external sliding shield for field adjustment of light level activation.
5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
6. Voltage: As required to control the load indicated on the drawings.
7. Failure Mode: Fails to the on position.
8. Load Rating: As required to control the load indicated on the drawings.
9. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

C. Locking Receptacle-Mounted Outdoor Photo Controls

1. Description: Plug-in locking type photo control unit complying with ANSI C136.10 for mounting on a compatible receptacle, listed and labeled as complying with UL 773.
2. Housing: Weatherproof, impact resistant UV stabilized polypropylene, color to be selected.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 1.5 to 1 turn-off to turn-on ratio with instant turn-on and delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.
8. Surge Protection: 160 joule metal oxide varistor.

D. Button Type Outdoor Photo Controls

1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
2. Housing: Weather resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
5. Voltage: As required to control the load indicated on the drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control the load indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of lighting control devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Occupancy Sensors: 48 inches above finished floor to the top of the box.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

- E. Install lighting control devices plumb and level, and held securely in place.
- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.
- G. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- H. Identify lighting control devices in accordance with Section 260553.
- I. Occupancy Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
 - 2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.
- J. Outdoor Photo Control Locations:
 - 1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
 - 2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.
- K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.
- L. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.
- M. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.

- C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- D. Test outdoor photo controls to verify proper operation, including time delays where applicable.
- E. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
- D. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
 - 4. Location: At project site.

END OF SECTION 260923

SECTION 262416 - PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260526 - Grounding and Bonding for Electrical Systems.
- C. Section 260529 - Hangers and Supports for Electrical Systems.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
- F. Section 262813 - Fuses: Fuses for fusible switches and spare fuse cabinets.
- G. Section 264300 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- E. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- F. NEMA PB 1 - Panelboards; 2011.
- G. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.

- H. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- L. UL 67 - Panelboards; Current Edition, Including All Revisions.
- M. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
- N. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- O. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- P. UL 943 - Ground-Fault Circuit-Interruptioners; Current Edition, Including All Revisions.
- Q. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.
- R. UL 1699 - Arc-Fault Circuit-Interruptioners; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - 1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
 - 2. Include wiring diagrams showing all factory and field connections.
 - 3. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
 - 4. Include documentation of listed series ratings upon request.
 - 5. Identify mounting conditions required for equipment seismic qualification.
- D. Manufacturer's equipment seismic qualification certification.
- E. Source Quality Control Test Reports: Include reports for tests designated in NEMA PB 1 as routine tests.
- F. Field Quality Control Test Reports.
- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- H. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- I. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Panelboard Keys: Two of each different key.
 - 3. See Section 262813 for requirements for spare fuses and spare fuse cabinets.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
 - 2. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
- B. Substitutions: See Section 016000 - Product Requirements.
- C. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:

- a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- b. Panelboards Containing Fusible Switches: Between -22 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide 200 percent rated neutral bus and lugs where indicated, where oversized neutral conductors are provided, or where panelboards are fed from K-rated transformers.
 - 3. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 - 4. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
 - c. Provide painted steel boxes for surface-mounted panelboards where indicated, finish to match fronts.

- 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
- 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 264300, list and label panelboards as a complete assembly including surge protective device.
- L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
 - 1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 - 2. Where accessory ground fault sensing and relaying equipment is used, equip companion overcurrent protective devices with ground-fault shunt trips.
 - a. Use zero sequence ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
- M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- N. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.
- O. Load centers are not acceptable.
- P. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Feed-through lugs.
 - 2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase and Neutral Bus Material: Copper.
2. Ground Bus Material: Copper.

D. Circuit Breakers:

1. Provide bolt-on type.
2. Provide thermal magnetic circuit breakers unless otherwise indicated.
3. Provide electronic trip circuit breakers where indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

F. Provide column-width panelboards with accessory column-width cable trough and pullbox where indicated.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Fusible Switches:

1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
 2. Fuse Clips: As required to accept indicated fuses.
 - a. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
 3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
 4. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- B. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
 3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.

- 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
 - 5) Ground fault pickup and delay where ground fault protection is indicated.
- b. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
- c. Provide communication capability where indicated: Compatible with system indicated.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
 - c. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
 - d. 100 Percent Rated Circuit Breakers: Listed for application within the panelboard where installed at 100 percent of the continuous current rating.
 - e. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
8. Do not use tandem circuit breakers.
9. Do not use handle ties in lieu of multi-pole circuit breakers.
10. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2.6 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.

- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Mount floor-mounted power distribution panelboards on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.
- J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- K. Provide grounding and bonding in accordance with Section 260526.
 - 1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
 - 2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
- L. Install all field-installed branch devices, components, and accessories.
- M. Provide fuses complying with Section 262813 for fusible switches as indicated.
- N. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- O. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 260573.

- P. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- Q. Provide filler plates to cover unused spaces in panelboards.
- R. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Emergency and night lighting circuits.
 - 2. Fire detection and alarm circuits.
 - 3. Communications equipment circuits.
 - 4. Intrusion detection and access control system circuits.
 - 5. Video surveillance system circuits.
- S. Identify panelboards in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 100 amperes. Tests listed as optional are not required.
- E. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- F. Test GFCI circuit breakers to verify proper operation.
- G. Test AFCI circuit breakers to verify proper operation.
- H. Test shunt trips to verify proper operation.
- I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262416

SECTION 262717 – EQUIPMENT WIRING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 26 0534 - Conduit.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 26 0537 - Boxes.
- D. Section 26 2818 - Enclosed Switches.

1.3 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).
- B. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2002 (R2008).
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.5 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.

- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Conform to NEMA WD 1.
 - 2. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Wiring Devices: As specified in Section 26 2726.
- C. Flexible Conduit: As specified in Section 26 0534.
- D. Wire and Cable: As specified in Section 26 0519.
- E. Boxes: As specified in Section 26 0537.

PART 3 EXECUTION

3.1 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION 262717

SECTION 262726 - WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates and covers.
- E. Floor box service fittings.
- F. Poke-through assemblies.
- G. Access floor boxes.

1.2 RELATED REQUIREMENTS

- A. Section 09 6900 - Access Flooring.
- B. Section 26 0533.16 - Boxes for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h, with Amendments (2017).
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2014g, with Amendment (2017).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- L. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.
- M. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
- 1.4 ADMINISTRATIVE REQUIREMENTS
- 1.5 SUBMITTALS
 - A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.6 QUALITY ASSURANCE
 - A. Comply with requirements of NFPA 70.
 - B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- 1.7 DELIVERY, STORAGE, AND PROTECTION
 - A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

- 2.1 WIRING DEVICES - GENERAL REQUIREMENTS
 - A. Provide wiring devices suitable for intended use with ratings adequate for load served.
 - B. Except where explicitly permitted, substitution of combination switch-and-receptacle devices for separate switches and receptacles is not permitted.
 - C. Wiring Device Applications:
 - 1. Receptacles Installed Outdoors or in Damp or Wet Locations: Use weather-resistant GFCI receptacles with weatherproof covers.
 - 2. Receptacles Installed in Dwelling Units: Use tamper-resistant receptacles.
 - 3. Provide GFCI protection for:
 - a. Receptacles installed within 6 feet of sinks.
 - b. Receptacles installed in kitchens.
 - c. Receptacles serving electric drinking fountains.

4. Single Receptacles Installed on Individual Branch Circuits: Provide receptacle ampere rating equal to branch circuit rating.
5. Flush Floor Service Fittings in Tile Floors: Use tile rings.
6. Flush Floor Service Fittings in Carpeted Floors: Use carpet flanges.

D. Wiring Device Finishes:

1. Provide wiring device finishes as described below, unless otherwise indicated.
2. Wiring Devices, Unless Otherwise Indicated: White with _____ stainless steel wall plate.
3. Surge Protection Receptacles: Blue.
4. Wiring Devices Connected to Emergency Power: Red with stainless steel wall plate factory engraved with text "Emergency".
5. Flush Floor Box Service Fittings: White wiring devices with aluminum cover and ring/flange.
6. Flush Poke-Through Service Fittings: White wiring devices with aluminum cover and aluminum flange.
7. Access Floor Boxes: White wiring devices with gray steel cover with insert to match floor covering.

2.2 WALL SWITCHES

A. Manufacturers:

1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
2. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
3. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

D. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

- E. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- F. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- G. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.
- H. Locking Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

2.3 WALL DIMMERS

- A. Manufacturers:
 - 1. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
 - 2. Lutron Electronics Company, Inc; Maestro Series: www.lutron.com/#sle.
 - 3. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
- C. Control: Slide control type with separate on/off switch.
- D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:
- E. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

2.4 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
 - 2. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.

3. Lutron Electronics Company, Inc; Designer Style: www.lutron.com/#sle.
 4. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 5. Substitutions: See Section 01 6000 - Product Requirements.
 6. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 2. NEMA configurations specified are according to NEMA WD 6.
- C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 3. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 4. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
 2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
 3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.
 4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.

5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations.

E. USB Charging Devices:

1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
 - a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port (Type A and Type C) USB charging device and receptacle, commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.

F. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.

1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.

2.5 WALL PLATES AND COVERS

A. Manufacturers:

1. Hubbell Incorporated; _____: www.hubbell-wiring.com/#sle.
2. Intermatic, Inc; _____: www.intermatic.com/#sle.
3. Leviton Manufacturing Company, Inc; _____: www.leviton.com/#sle.
4. Lutron Electronics Company, Inc; _____: www.lutron.com/#sle.
5. Pass & Seymour, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
6. Substitutions: See Section 01 6000 - Product Requirements.
7. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer.

B. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Size: Standard; _____.
3. Screws: Metal with slotted heads finished to match wall plate finish.

C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

D. Weatherproof Receptacle Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

- E. Weatherproof Receptacle Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.6 FLOOR BOX SERVICE FITTINGS

A. Manufacturers:

1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

- B. Description: Service fittings compatible with floor boxes provided under Section 26 0533.16 with components, adapters, and trims required for complete installation.

C. Above-Floor Service Fittings:

1. Single Service Pedestal Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle.
2. Single Service Pedestal Communications Outlets:
 - a. Configuration: One 1 inch bushed opening.
 - b. Voice and Data Jacks: As specified in Section 27 1005.
3. Single Service Pedestal Furniture Feed:
 - a. Configuration: One 3/4 inch knockout.
4. Dual Service Pedestal Combination Outlets:
 - a. Configuration:
 - 1) Power: One standard convenience duplex receptacle.
 - 2) Communications: One 1 inch bushed opening.
 - 3) Voice and Data Jacks: As specified in Section 27 1005.
 - b. Provide barrier to separate line and low voltage compartments.

D. Flush Floor Service Fittings:

1. Single Service Flush Convenience Receptacles:
 - a. Cover: Rectangular.
 - b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
2. Single Service Flush Communications Outlets:
 - a. Cover: Rectangular.
 - b. Configuration: _____.
 - c. Voice and Data Jacks: As specified in Section 27 1005.
3. Accessories:
 - a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
 - b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.7 POKE-THROUGH ASSEMBLIES

A. Manufacturers:

1. Hubbell Incorporated; _____: www.hubbell.com/#sle.
2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

C. Above-Floor Service Fittings:

1. Single Service Pedestal Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle.
2. Single Service Pedestal Communications Outlets:
 - a. Configuration: One 1 inch bushed opening.
 - b. Voice and Data Jacks: As specified in Section 27 1005.
3. Dual Service Pedestal Combination Outlets:
 - a. Configuration:
 - 1) Power: One standard convenience duplex receptacle.
 - 2) Communications: One 1 inch bushed opening.
 - 3) Voice and Data Jacks: As specified in Section 27 1005.
 - b. Provide barrier to separate line and low voltage compartments.

D. Flush Floor Service Fittings:

1. Single Service Flush Convenience Receptacles:
 - a. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
2. Single Service Flush Communications Outlets:
 - a. Configuration: _____.
 - b. Voice and Data Jacks: As specified in Section 27 1005.
3. Dual Service Flush Combination Outlets:
 - a. Cover: Hinged door(s).
 - b. Configuration:
 - 1) Power: One standard convenience duplex receptacle(s).
 - 2) Communications: _____.
 - 3) Voice and Data Jacks: As specified in Section 27 1005.
4. Accessories:
 - a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

2.8 ACCESS FLOOR BOXES

A. Manufacturers - Access Floor Boxes:

1. Hubbell Incorporated; _____: www.hubbell-wiring.com/#sle.
 2. Thomas & Betts Corporation; _____: www.tnb.com/#sle.
 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Manufacturers - Access Floor Boxes with Pre-wired Connectors for Manufactured Wiring Systems:
1. AFC Cable Systems Inc; _____: www.afcweb.com/#sle.
 2. RELOC Wiring Solutions, a brand of Acuity Brands, Inc; _____: www.relocwiring.com/#sle.
 3. Wiremold, a brand of Legrand North America, Inc; _____: www.legrand.us/#sle.
 4. Substitutions: See Section 01 6000 - Product Requirements.
 5. Source Limitations: Provide access floor boxes with pre-wired connectors produced by the same manufacturer as the manufactured wiring system used for this project.
- C. Description: Metallic multi-service box suitable for mounting in access floor system specified in Section 09 6900.
- D. Configuration:

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that core drilled holes for poke-through assemblies are in proper locations.
- H. Verify that openings in access floor are in proper locations.
- I. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches above finished floor.
 - b. Wall Dimmers: 48 inches above finished floor.
 - c. Fan Speed Controllers: 48 inches above finished floor.
 - d. Receptacles: 18 inches above finished floor or 6 inches above counter.
 - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
 - 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
 - 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

- I. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- J. Install wall switches with OFF position down.
- K. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- L. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Identify wiring devices in accordance with Section 26 0553.
- Q. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

1.2 RELATED REQUIREMENTS

- A. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 262416 - Panelboards: Fusible switches.
- C. Section 262816.16 - Enclosed Switches: Fusible switches.

1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.
- E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses; Current Edition, Including All Revisions.
- F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.
- G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.
- H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Switches for Panelboards: See Section 262416.
 - b. Fusible Enclosed Switches: See Section 262816.16.
2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.

1. Spare Fuse Cabinet: Include dimensions.

C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements, for additional provisions.
2. Extra Fuses: One set(s) of three for each type and size installed.
3. Fuse Pullers: One set(s) compatible with each type and size installed.
4. Spare Fuse Cabinet Keys: Two.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation; _____: www.cooperindustries.com/#sle.
SCHRADERGROUP FUSES
A Hord Coplan Macht Studio
Project: 225180.00

- B. Littelfuse, Inc; _____: www.littelfuse.com/#sle.
- C. Mersen; _____: ep-us.mersen.com/#sle.
- D. Substitutions: See Section 016000 - Product Requirements.

2.2 APPLICATIONS

- A. Service Entrance:
 - 1. Fusible Switches up to 600 Amperes: Class J, time-delay.
 - 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- B. Feeders:
 - 1. Fusible Switches up to 600 Amperes: Class J, fast-acting, non-time-delay.
 - 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- C. General Purpose Branch Circuits: Class RK1, time-delay.
- D. Individual Motor Branch Circuits: Class RK1, time-delay.
- E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.
- F. Primary Protection for Control Transformers: Class CC, time-delay.

2.3 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
 - 1. Class RK1, Time-Delay Fuses:
 - 2. Class RK1, Fast-Acting, Non-Time-Delay Fuses:
 - 3. Class RK5, Time-Delay Fuses:
 - 4. Class RK5, Fast-Acting, Non-Time-Delay Fuses:

- H. Class J Fuses: Comply with UL 248-8.
 - 1. Class J, Time-Delay Fuses:
 - 2. Class J, Fast-Acting, Non-Time-Delay Fuses:
- I. Class L Fuses: Comply with UL 248-10.
 - 1. Class L, Time-Delay Fuses:
 - 2. Class L, Fast-Acting, Non-Time-Delay Fuses:
- J. Class T Fuses: Comply with UL 248-15.
- K. Class CC Fuses: Comply with UL 248-4.
 - 1. Class CC, Time-Delay Fuses:
 - 2. Class CC, Fast-Acting, Non-Time-Delay Fuses:
- L. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- M. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.
 - 2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

2.4 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.
- B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet in convenient location in main electrical room unless otherwise indicated.
- D. Identify spare fuse cabinet in accordance with Section 260553.

END OF SECTION 262813

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SECTION 262816.13 - ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding for Electrical Systems.
- B. Section 260529 - Hangers and Supports for Electrical Systems.
- C. Section 260548 - Vibration and Seismic Controls for Electrical Systems.
 - 1. Includes requirements for the seismic qualification of equipment specified in this section.
- D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 260573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e (Amended 2017).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.
- D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

- I. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- J. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers where indicated.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
 1. Include characteristic trip curves for each type and rating of circuit breaker upon request.
- C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
- D. Manufacturer's equipment seismic qualification certification.
- E. Field Quality Control Test Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- G. Project Record Documents: Record actual installed locations of enclosed circuit breakers.

- H. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE; _____: www.electrification.us.abb.com/#sle.
- B. Eaton Corporation; _____: www.eaton.com/#sle.
- C. Schneider Electric; Square D Products; _____: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc; _____: www.usa.siemens.com/#sle.
- E. Substitutions: See Section 016000 - Product Requirements.
- F. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.

- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Seismic Qualification: Provide enclosed circuit breakers and associated components suitable for application under the seismic design criteria specified in Section 260548 where required. Include certification of compliance with submittals.
- D. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- E. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
 - 2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
 - 3. Label equipment utilizing series ratings as required by NFPA 70.
- F. Conductor Terminations: Suitable for use with the conductors to be installed.
- G. Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 400 amperes.
- H. Provide electronic trip circuit breakers for circuit breaker frame sizes 400 amperes and above.
- I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
 - 3. Provide surface-mounted or flush-mounted enclosures as indicated.
- L. Provide externally operable handle with means for locking in the OFF position.
- M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
 2. Where accessory ground fault sensing and relaying equipment is used, equip companion circuit breakers with ground-fault shunt trips.
 - a. Use zero sequence ground fault detection method unless otherwise indicated.
 - b. Provide test panel and field-adjustable ground fault pick-up and delay settings.
 - c. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control ground fault delay functions for system coordination purposes.
- N. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - b. 14,000 rms symmetrical amperes at 480 VAC.
 2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 3. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.
- C. Conductor Terminations:
1. Provide mechanical lugs unless otherwise indicated.
 2. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.

- E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - 1. Provide the following field-adjustable trip response settings:
 - a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - b. Long time delay.
 - c. Short time pickup and delay.
 - d. Instantaneous pickup.
 - e. Ground fault pickup and delay where ground fault protection is indicated.
 - 2. Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.
 - 3. Provide communication capability where indicated: Compatible with system indicated.
- F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- G. Provide the following circuit breaker types where indicated:
 - 1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - 2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
 - 3. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.
- H. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install enclosed circuit breakers plumb.
- F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- H. Provide grounding and bonding in accordance with Section 260526.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 260573.
- K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
- L. Identify enclosed circuit breakers in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than _____ amperes. Tests listed as optional are not required.
- D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- E. Test GFCI circuit breakers to verify proper operation.
- F. Test shunt trips to verify proper operation.

- G. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262816.13

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 PROJECT INCLUDES

- A. Interior luminaires.
- B. Lamps.
- C. Luminaire accessories.

1.2 RELATED REQUIREMENTS

- A. Section 260537 - Boxes.
- B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 260923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- D. Section 262726 - Wiring Devices: Manual wall switches and wall dimmers.
- E. Section 265200 – Gymnasium Theatrical Lighting.

1.3 REFERENCE STANDARDS

- A. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple-Supply Type); 2002.
- B. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; Consolidated-2002.
- C. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (R2008).
- D. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002.
- E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.
- F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

- G. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts; National Electrical Manufacturers Association; 2011.
- H. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2006.
- I. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.
- K. UL 1029 - High-Intensity-Discharge Lamp Ballasts; Current Edition, Including All Revisions.
- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
- 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
- 3. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:

- 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. Ballasts: Include wiring diagrams and list of compatible lamp configurations.
 2. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
- D. Certificates for Dimming Ballasts: Manufacturer's documentation of compatibility with dimming controls to be installed.
- E. Field Quality Control Reports.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.
 2. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type. Exclude LED lamps from this section.
 3. Extra Ballasts: Two percent of total quantity installed for each type, but not less than one of each type. Do not include LED Drivers.
- I. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Conform to requirements of NFPA 70 and NFPA 101.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide two year manufacturer warranty for all linear fluorescent ballasts.
- C. Provide five year pro-rata warranty for batteries for emergency lighting units.
- D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.
- B. Substitutions: See Section 016000 - Product Requirements.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

H. LED Luminaires: Listed and labeled as complying with UL 8750.

1. Provide lumen output and color temperature as indicated on the Luminaire schedule.
2. Provide LED driver as indicated on the Luminaire schedule. Provide 0-10v dimming driver where required.
3. LED Luminaires shall be warranted for a minimum of 10 years.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 260537 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.

- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members, or to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- F. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
 - 2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- G. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet between supports.
 - 4. Install canopies tight to mounting surface.
 - 5. Unless otherwise indicated, support pendants from swivel hangers.
- H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.

- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.6 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- D. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265100

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SECTION 271005 - STRUCTURED CABLING FOR VOICE AND DATA

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Communications system design requirements.
- B. Communications pathways.
- C. Copper cable and terminations.
- D. Fiber optic cable and interconnecting devices.
- E. Communications identification.
- F. Telecommunications service entrance to building(s).
- G. Cabling and pathways inside building(s).
- H. Cabling and pathways connecting building(s).
- I. Distribution frames, cross-connection equipment, enclosures, and outlets.
- J. Grounding and bonding the telecommunications distribution system.

1.2 RELATED REQUIREMENTS

- A. Section 337119 - Electrical Underground Ducts and Manholes.
- B. Section 078400 - Firestopping.
- C. Section 260526 - Grounding and Bonding for Electrical Systems.
- D. Section 260534 - Conduit.
- E. Section 260536 - Cable Trays for Electrical Systems.
- F. Section 260537 - Boxes.
- G. Section 262726 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.

- B. CEA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association; Revision E, 2005.
- C. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements; Insulated Cable Engineers Association; 2012. (ANSI/ICEA S-90-661)
- D. NECA/BICSI 568 - Standard for Installing Building Telecommunications Cabling; National Electrical Contractors Association; 2006. (ANSI/NECA/BICSI 568)
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; Telecommunications Industry Association; 2012.
- G. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; Telecommunications Industry Association; Rev A, 2009.
- H. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; Telecommunications Industry Association; 1998 (R 2002).
- I. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; Telecommunications Industry Association; Rev A, 2015.
- J. TIA-526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Telecommunications Industry Association; Rev C, 2015.
- K. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; Telecommunications Industry Association; 2015.
- L. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Telecommunications Industry Association; Rev C, 2009 (with Addenda; 2014).
- M. TIA-568-C.3 - Optical Fiber Cabling Components Standard; Telecommunications Industry Association; 2008 (with Addenda; 2011).
- N. TIA-569-C - Telecommunications Pathways and Spaces; Telecommunications Industry Association; Rev C, 2012 (with Addenda; 2013).
- O. TIA-570-C - Residential Telecommunications Infrastructure Standard; Telecommunications Industry Association; Rev C, 2012.
- P. TIA-606-B - Administration Standard for the Telecommunications Infrastructure; Telecommunications Industry Association; Rev B, 2012.

- Q. TIA-607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Telecommunications Industry Association; Rev B, 2012 (with Addenda; 2013).
- R. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.
- S. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- T. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; Current Edition, Including All Revisions.
- U. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.
- V. USDA RUS 345-83 - Gas Tube Surge Arrestors (PE-80); US Department of Agriculture; 1982.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods.
 - 3. Testing reports/certifications of installation/cable lengths.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Certified Registered Communications Distribution Designer (RCDD).
- D. Manufacturer Qualifications.
- E. Evidence of qualifications for installer.
- F. Field Test Reports.
- G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.
 - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 - 3. Identify distribution frames and equipment rooms by room number on contract drawings.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 10 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 10 years experience in the installation and testing of the type of system specified, and:
 - 1. Bidder shall be a member of BICSI (Building Industry Consulting Service International).
 - 2. Supervisors and installers factory certified by manufacturers of products to be installed – minimum of (2) individuals certified.
 - 3. The Successful Bidder shall have on staff at least one employee who holds a BICSI RCDD (Registered Communications Distribution Designer) certification. Provide proof of certification with submittals.
 - 4. “A minimum of 75% of all staff providing work as part of this specification shall hold a BICSI Installer 2 certification (INSTC for copper and INSTF for fiber) specific to their area of labor (copper and/or fiber) OR the BICSI Technician (TECH). Provide proof of current certification with submittals.
 - 5. The Successful Bidder shall have on staff at least one employee who holds a BICSI RTPM (Registered Telecommunications Project Manager) certification. Provide proof of certification with submittals.
 - 6. The Successful Bidder must be a certified Hubbell installer and provide proof of being part of the Hubbell Mission Critical Warranty Program.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.7 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 60 period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cabling and Equipment:

B. ~~Mohawk~~ **Hubbell Premise Wiring** Copper Cabling

1. Substitutions:
 - a. ~~Hubbell Premise Wiring.~~ **Ortronics**
 - b. See Section 260100 - Product Requirements.

2.2 SYSTEM DESIGN

A. Provide a complete permanent Fiber and Cat 6A system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures, cabinets, racks, and outlets.

1. Comply with TIA-568 (cabling) and TIA-569 (pathways), latest editions (commercial standards). Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
2. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
3. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
4. The District will furnish the switches, servers, and wireless access points (WAP'S). Provide end-to-end wiring starting at the incoming service from the pole to the Electric Room, from Electric Room to the MDF Room switch to the patch panels, from the MDF patch panels to the IDF, from the IDF patch panels to the data ports or WAP's. UPS will be furnished and installed by the district. Contractor shall provide Nema 5-20R receptacle outlet at each rack. Quantity per drawings.
5. Provide vertical mount PDUs at each rack.
 - a. Hubbell cat#PR10420

B. Capacity:

1. Building Entrance: Existing
2. Horizontal Cabling
 - a. MDF to IDF's
 - 1) ~~Armored 6 strand single mode (OS2) fiber optic. Hubbell PN# HFC15006PS and (Addendum 4) 12 strand multi mode armored (OM5) fiber optic. Hubbell PN # HFC15012P5~~
 - 2) CAT 6A cabling to outlet ports:
 - (a) Refer to the drawings for exact counts of ports per outlet device.
 - (b) Refer to floor plans for camera locations (1 drop per location). Coordinate final camera locations with district prior to rough-in.
 - (c) Refer to floor plans for WAP locations (4 drops per location)

Coordinate final WAP locations with district prior to rough-in.

- C. Main Distribution Frame (MDF): Centrally located support structure for terminating backbone cables, functioning as point of presence to external service provider.
 - 1. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.
- D. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
- E. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.
- F. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.3 PATHWAYS

- A. Conduit: As specified in Section 260534; provide pull cords in all conduit.
- B. Cable Trays: As specified in Section 260536.
- C. Underground Service Entrance: PVC, Type EPC-40 conduit.

2.4 COPPER CABLE AND TERMINATIONS

- A. Copper Horizontal Cable: TIA/EIA-568 Category 6A solid conductor unshielded twisted pair (UTP), 23 AWG, 100 ohm; 4 individually twisted pairs; covered with jacket colors as indicated below and complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444.
 - 1. In plenums, provide NFPA 70 type CMP plenum-rated cable. ~~Mohawk PN#M59146~~ **Hubbell PN#C6ASPDSB. (Addendum 4)**
 - 2. Testing: Furnish factory reel tests.
 - 3. Color coding of cable shall be as follows for the listed applications. Note Red shall be reserved for Fire Alarm Cabling only.
 - a. Data Drops (standard drops) - Blue
- C. Copper Cable Terminations:
 - 1. Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
- D. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.

1. Performance: 500 mating cycles.
2. Keystone jacks shall be Hubbell HXJ6X.
3. Terminations shall be completed in ANSI TIA-568B pinout fashion

2.5 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

A. Fiber Optic Interconnecting Devices:

1. Connector Type: Type LC.
2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
3. Maximum Attenuation/Insertion Loss: 0.3 dB.

B. Fiber Optic Backbone Cable - Multimode Fiber Cable:. Provide 1 – 12 Strand multimode fiber and 1-6 strand single mode fiber from each IDF to the MDF.

1. Pre-terminated, tight buffered, interlocking armored cable, riser, 50 microns, OM5, multimode mode indoor/outdoor and plenum rated. Comply with TIA-492AAAD and and TIA/EIA – 568.
2. Jacket Color: Aqua
3. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
4. Jacket shall be imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches
5. Cable should be UL listed for installation and purpose

D. Fiber Patch Cords shall consist of quantities as required but shall consist of a minimum as follows:

1. 10 each Hubbell # DFPCLCSCE1MM, 1 meter, aqua jacket, Multimode

F. Fiber Optic Adapters and Connectors: Duplex LC, push-on-push-off type, multimode adaptors with zirconia ceramic alignment sleeves; complying with relevant parts and addenda to latest edition of TIA/EIA-568 and with maximum attenuation of 0.3 dB at 1300 nm with less than 0.2 dB change after 500 mating cycles when tested in accordance with TIA-455-21.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA-606.

B. All labeling shall be machine print. No handwritten labeling shall be accepted. Each cable shall be labeled on both the patch panel and on the wall faceplate/biscuit box as applicable

2.7 CROSS-CONNECTION EQUIPMENT

- A. Connector Blocks for Category 6A and Up Cabling: Type 110 insulation displacement connectors; capacity sufficient for cables to be terminated plus 25 percent spare.
- B. Patch Panels for Copper Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum; cabling terminated on Type 110 insulation displacement connectors; printed circuit board interface. Provide Hubbell #HP6A48, Comes with Rear management bar
1. Jacks: Non-keyed RJ-45, suitable for and complying with same standard as cable to be terminated; maximum 48 ports per standard width panel.
 2. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
 3. Labels: Factory installed laminated plastic nameplates above each port, numbered per district standards; comply with TIA/EIA-606 using encoded identifiers. No exceptions unless pre-approved by District.
 - a. District standard label for wall plates and WAPs: Room # - Port #
 - b. District standard label for camera ports: Room/Corridor # - Port #
 - c. District standard label for all other ports: Room/Corridor # - Port #
 4. Provide incoming cable strain relief and routing guides on back of panel.
 5. Patch Cords: Provide one patch cord for each pair of patch panel ports.
 - a. Patch Cords shall be as manufactured by FS; <https://www.fs.com/>
 1. 30% - 5ft Yellow FS Part #148293
 2. 20% - 5ft Blue FS Part #70748
 3. 20% - 1ft Yellow FS Part #148281
 4. 20% - 1ft Green FS Part #148282
 5. 10% - 2ft Green FS Part #148285
 6. For every 1 piece of building automation equipment that requires a network connection, provide (1) FS Part#185700 (white) and (20) FS Part #185701 as spare.
 6. Manufacturer's patch cords must be used to provide a Channel Warranty
 7. Category 6A panels shall meet or exceed Category 6A transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA-568.2-D, Transmission Performance specifications for 4-pair 100 OHM cat 6A cabling systems
 8. Panels shall be tested to 150% of IEEE 802.3bt DTE Power specification with no degradation of performance or materials
 9. Stainless steel face plates must be used. Hubbell SSFL series
- C. Patch Panels for Fiber Optic Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
1. Adaptors: As specified above under FIBER OPTIC CABLING; maximum of 24 duplex adaptors per standard panel width.
 2. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA/EIA-606 using encoded identifiers.
 3. Provide incoming cable strain relief and routing guides on back of panel.
 4. Provide rear cable management tray at least 8 inches deep with removable cover.
 5. Provide dust covers for unused adaptors.
 6. Patch Cords: Provide one patch cord for each pair of patch panel ports.

2.8 ENCLOSURES

- A. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
 - 1. Size: 48 inches wide by 96 inches high.
 - 2. Do not paint over UL label.
- B. Equipment Racks and Cabinets: CEA-310 standard 19 inch wide component racks.
 - 1. Floor Mounted Racks: 16 gauge steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug. Provide Hubbell #HPW84RR19D, with Vertical Cable Managers VME614C2
 - 2. Provide 2-post racks (Hubbell HPW90RR19).
- C. Building Entrance Protector: Factory fabricated panel to connect incoming cable and interior cable to protector modules.
 - 1. Capacity: One protector module per pair in incoming cable.
 - 2. Protector Modules: Type rated for the application.
 - a). Solid State Type: Complying with UL 497.
 - 3. Incoming Side: Provide connector blocks of type specified.
 - 4. Outgoing Side (to Interior): Backbone cable wired to connector blocks.
- D. Outlet Boxes: For flush mounting in walls; depth as required to accommodate cable manufacturers recommended minimum conductor bend radius.
 - 1. Size, unless otherwise indicated: 4 inches square by 3.5 inches deep.
 - 2. Faceplates: Stainless steel. Final material/color selection by Architect. Faceplates shall coordinate with connectors provided. Include label and label cover with faceplate. Machine print.
 - 3. Labels: Comply with TIA/EIA-606 using encoded identifiers; label each jack on the face plate per District provided labeling schematic.

2.9 POWER DISTRIBUTION UNIT (PDU)

- A. Equipment Racks and Enclosures:
 - 1. Hubbell cat#PR10420

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), NECA/BICSI 568, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with latest editions and addenda of TIA-570, TIA-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- C. Comply with Communication Service Provider requirements.
- D. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

3.2 INSTALLATION OF PATHWAYS

- A. Install with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit:
 - 1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
 - 2. Leave pull cords in place where cables are not initially installed.
 - 3. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
 - a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
 - b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.
 - c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
 - d. Under floor slabs, locate conduit at 12 inches, minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.
 - 4. Provide pull string in all under slab conduit.
- C. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.
- D. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 078400.

3.3 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable

- diameter.
 - 2. Do not over-cinch or crush cables.
 - 3. Do not exceed manufacturer's recommended cable pull tension.
 - 4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
 - 5. Cable runs shall not exceed 295 feet.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
- 1. At Distribution Frames: 120 inches.
 - 2. At Outlets including wall - Copper: 12 inches.
 - 3. At Outlets - Optical Fiber: 39 inches.
 - 4. At WAP locations: 120 inches
 - 5. At security camera locations: 120 inches
 - 6. At outlets servicing mechanical equipment and controls: 120 inches
- C. Copper Cabling:
- 1. Category 6A: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 - 3. Copper Cabling Not in Conduit: Use only type CMP plenum-rated cable as specified.
- D. Fiber Optic Cabling:
- 1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 - 2. Support vertical cable at intervals as recommended by manufacturer.
- E. Floor-Mounted Racks and Enclosures: Permanently anchor to floor and ceiling in accordance with manufacturer's recommendations.
- F. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
- 1. Cables: Install color coded labels on both ends.
 - 2. Outlets: Label each jack on its face plate according to District standards with a unique numerical identifier.
 - 3. Patch Panels: Label each jack according to District standards with a unique numerical identifier.
- G. Each data rack shall consist of the following (in order from top to bottom). Field coordinate exact order with District.
- 1. Fiber connection at top of rack
 - 2. 48-port patch panel
 - 3. Horizontal panduit

4. Network switch
5. 48-port patch panel
6. Horizontal Panduit
7. Network Switch
8. Back-up UPS (furnished and installed by District)

3.4 FIELD QUALITY CONTROL

- A. Comply with inspection and testing requirements of specified installation standards.
- B. Visual Inspection:
 1. Inspect cable jackets for certification markings.
 2. Inspect cable terminations for color coded labels of proper type.
 3. Inspect outlet plates and patch panels for complete labels.
 4. Inspect patch cords for complete labels.
- C. Testing - Copper Cabling and Associated Equipment:
 1. Test backbone cables after termination but before cross-connection.
 2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
 3. Test operation of shorting bars in connection blocks.
 4. Category 6A Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
- D. Testing - Fiber Optic Cabling:
 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
 2. Multimode Backbone: Perform tests in accordance with TIA/EIA-526-14 Method B.

END OF SECTION 271005

SECTION 283100 - FIRE ALARM & EMERGENCY VOICE COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of Contract, including General and Supplementary Conditions and other General Requirements sections, apply to the work specified in this section.

1.2 WORK DESCRIPTION:

- A. Extend existing Manufacturer: Basis of Design is a Simplex Brand 4100 ES Emergency Communication Voice Alarm FACU in accordance with the attached Construction Bid Drawings and Specifications (Simplex Brand as sold and supported by Johnson Controls JCI).
 - 1. Equal products shall be allowed to be submitted for approval provided they meet all requirements of these construction documents. For approval, provide product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification. The owner / engineer shall review pre-bid submittals from all the manufacturers to ensure compliance to the specification 10 days prior to bid. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.

Basis of Design: Simplex Brand 4100 ES Emergency Communication Voice Alarm

- a. Sound system map in accordance with map presented on drawings.
- b. Wiring diagrams from manufacturer.
- c. Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator. Point-to-Point wiring diagrams showing the points of connection and terminals used for all electrical field connections in the system, including all interconnection between the fire alarm system and all equipment or systems which are supervised and controlled by the fire alarm system.
- d. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
- e. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, Sensor, and auxiliary control circuits.
- f. Operating instructions for FACP.
- g. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include

data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.

- h. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
 - i. Provide a fire alarm riser diagram showing peripheral devices, control and annunciation panels, interlocks with other system (e.g. mechanical), and interconnections to other systems (e.g. energy management, telephone, elevator controller, etc.).
- B. The system shall include new devices in accordance with the project drawings consisting of new controls, pull stations, smoke/heat/duct sensors, annunciator panel, audio visible units, visible only units and any other appurtenances necessary for complete and operational system.
- C. The complete installation is to conform to the applicable sections of the current IBC, NFPA-72, NFPA-70 (with particular attention to Article 760), and any other locally enforced requirements of the Authority Having Jurisdiction.

1.3 QUALITY ASSURANCE:

- A. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the UJOZ category by Underwriters Laboratories, Inc. (UL), and shall bear the "U.L." label. Partial listing shall NOT be acceptable.
- B. The catalog numbers specified under this section are those of Simplex Time Recorder and constitute the type, product quality, material, and designed operating features. No substitutions will be accepted.

1.4 SHOP DRAWINGS:

- A. The contractor shall submit a package which is sufficiently detailed to show that the proposed system meets the specifications. The package shall contain the following:
 - 1. Catalog cuts of components, including system cabinets with physical dimensions.
 - 2. Circuited Floor Plans showing the types and arrangement of connections among the components, including cable types.
 - 3. Tabulations verifying the extra capacity required below. Show tabulations for points, power supplies, and battery standby.
 - 4. Without these, the package will be rejected without review.

1.5 WARRANTY:

- A. The Contractor shall guarantee the system to perform as specified and be free from defects in materials and workmanship for one year from date of Owner acceptance. Any repairs during this time are to be provided by the Contractor during normal working hours at no cost to the Owner.

1.6 OPERATION:

- A. The actuation of any alarm initiating device such as a manual pull station, fire sensor or sprinkler flow switch shall cause the following to occur:
1. Sound all audible and visual alarm signals until manually acknowledged and reset.
 2. Display the device in alarm label at the control panel.
 3. Display the device in alarm label at the annunciator panel if supplied.
 4. Transmit the alarm to an approved supervising station via internal DACT or Alarm Relay Module.

PART 2 - PRODUCTS

2.1 MAIN PANEL:

- A. Fire Alarm Master Controller CPU: Modernize and expand the existing Fire Alarm Controls adding additional modules and enclosures as necessary. Where required demolish and/or consolidate existing legacy controls into modern 4100 U/ES type enclosures. At a minimum provide and power as noted the following in quantities necessary to complete the project:
1. 4100-9111 Simplex 4100 U/ES System Master Controller
 2. 4100-9621 Simplex 4100 U/ES Digital Audio w/Microphone
 3. 4100-5101 Simplex 4100 U/ES expansion power supply.
 4. 4100-1329 Simplex 4100 U/ES 100 W Digital Amplifier.
 5. 4100-XXXX Related Support Modules as appropriate.

2.2 SYSTEM COMPONENTS

1. Both Initiating and Notification material supplied shall be addressable whenever possible. Where specified as "Fire Alarm Only" supply notification appliances labeled FIRE as opposed to ALERT. Where specified non-voice alarm supply appropriate equivalent tone only device. Consult the Johnson Controls representative regarding substitutions and appropriate equipment selections.
- B. Addressable TrueAlert Speaker/Visual Combination Alarm: Simplex 49SV-APPL (C or W) with 49SVC- (CW or WW) designate ALT for ALERT Cover.
1. White housing with a clear lens, wall-mount
 2. Fully synchronized per ADA and UL Standard 1971
 3. Individually addressable point control of both Visible and Audible operation
 4. Strobe intensity shall be as indicated or required by the application (15/ 30/75/110/135/185 cd))
 5. High quality voice and tone reproduction with multi-tap and capacitor input connection.
 6. Surface-mount adapters where required (4905-9947)

7. Wire guards where indicated (4905-9998)
- C. Addressable TrueAlert Speaker Alarm: Simplex 49SO-APPL (C or W) with 49SOC- (CW or WW) designate ALT for ALERT Cover.
1. Off-white housing, ceiling-mount
 2. Individually addressable point control of Audible operation
 3. High quality voice and tone reproduction with multi-tap and capacitor input connection.
- D. Addressable TrueAlert Visual Alarm: Simplex 49VO-WWA or 4906-9204
1. White housing with a clear lens, wall-mount
 2. Individually addressable point control of Visible operation
 3. Fully synchronized per ADA and UL Standard 1971
 4. Strobe intensity shall be as indicated or required by the application (15/ 30/75/110 cd)
 5. Surface-mount adapters where required (4905-9940)
 6. Wire guards where indicated (4905-9961)
- E. Addressable TrueAlert Visual Alarm for Weather-Proof: Simplex 49VO-APPLW-O with 49VOC-WRALT-O ALERT Cover.
1. Red housing with a clear lens, wall-mount
 2. Individually addressable point control of Visible operation
 3. Fully synchronized per ADA and UL Standard 1971
 4. Strobe intensity shall be as indicated or required by the application (20/ 30/75cd)
 5. Surface Mount Weather-Proof Box (49WPBB-AVVOWR)
- F. Conventional TrueAlert Speaker/Visual Combination Alarm: Simplex 4906-9153 with 4905-9846 Cover
1. White housing with a clear lens, wall-mount
 2. Fully synchronized per ADA and UL Standard 1971
 3. Strobe intensity shall be as indicated or required by the application (15/ 30/75/110 cd)
 4. High quality voice and tone reproduction with multi-tap and capacitor input connection.
 5. Surface-mount adapters where required (4905-9947)
 6. Wire guards where indicated (4905-9998)
- G. Conventional TrueAlert Speaker Alarm: Simplex 4902-9721 with 2905-9946 Tile Bridge
1. Off-white housing, ceiling-mount
 2. High quality voice and tone reproduction with multi-tap and capacitor input connection.

H. Conventional TrueAlert Visual Alarm: Simplex 4906-9103 with 4905-9842 Cover

1. White housing with a clear lens, wall-mount
2. Fully synchronized per ADA and UL Standard 1971
3. Strobe intensity shall be as indicated or required by the application (15/ 30/75/110 cd))
4. Surface-mount adapters where required (4905-9940)
5. Wire guards where indicated (4905-9961)

I. Conventional TrueAlert Visual Alarm for Weather-Proof: Simplex 4906-9105

1. Red housing with a clear lens, wall-mount
2. Fully synchronized per ADA and UL Standard 1971
3. Strobe intensity shall be as indicated or required by the application (15/ 60/75cd))
4. Surface Mount Weather-Proof Box (4905-9828)

J. Conventional Audible for Weather-Proof: ET-1010 with SBB-R Back Box

1. Red housing.
2. High quality voice and tone reproduction with multi-tap and capacitor input connection selectable (1/8, 1/4, 1/2, 1, 2, 4, 8 Watt @ 70.7 Volt).

K. Conventional TrueAlert Loudspeaker for Wide Area Indoor/Outdoor

1. Where a single loudspeaker device is specified for wide area audible notification operation supply Simplex 49OMNI-05-A. Device shall be tapped at 100 Watt / 70.7 Volt

L. Eaton Wheelock Audible for Weather-Proof: ET-1010 with SBB-R Back Box

1. Red housing.
2. High quality voice and tone reproduction with multi-tap and capacitor input connection selectable (1/8, 1/4, 1/2, 1, 2, 4, 8 Watt @ 70.7 Volt).

M. Eaton Wheelock Directional Loudspeaker: STH-15SR with SHMP-R Plate

1. Red housing.
2. High quality voice and tone reproduction with multi-tap and capacitor input connection selectable (0.9, 1.8, 3.8, 7.5, 15 Watt @ 70.7 Volt).

N. IDNet Addressable Pull Station for ADA approved operation; Simplex #4099-9020

Single-action operation with ADA approved pull-to-operate actuation mechanism

1. Red Lexan housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
2. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
3. Surface Mount supply Box (2975-9178)

4. Wire guards where indicated (2099-9800)
- O. IDNet Addressable Pull Station for Rugged/Vandal; Simplex #2099-9138 with 4090-9051
1. Single-action operation with pull-to-activate lever
 2. Red cast metal housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
 3. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 4. Surface Mount supply Cast Aluminum Box (2975-9211)
- P. IDNet Addressable Pull Station for Weather-Proof; Simplex #2099-9144 with 4090-9051
1. Single-action operation pull-to-activate lever
 2. Red cast metal housing with clearly visible operating instructions provided on the cover. The words FIRE ALARM shall appear on the front in white letters
 3. Key operated test-reset lock designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- Q. Detection Devices – General
1. Sensors shall include analog sensing and addressable communication, and shall connect to the fire alarm control panel's Signaling Line Circuits.
 2. Sensors shall mount to the same addressable base which includes a status indicator LED.
 3. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system.
 4. The sensors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature. Provide surface-mount adapter plate where required.
 5. The sensors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.
- R. TrueAlarm Smoke Sensor (Photoelectric); Simplex #4098-9714
1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
 2. Supply Standard Addressable Base Simplex #4098-9792 or Simplex #4098-9794 where Piezo Electric Sounder is specified.
- S. TrueAlarm Heat Sensor (Thermal); Simplex #4098-9733E
1. Thermal detectors shall be intelligent addressable devices rated to operate at 135 or 155 degrees Fahrenheit and be field-selectable with or without a rate-of-rise element rated at 15 degrees F per minute.
 2. Supply Standard Addressable Base Simplex #4098-9792E.

- T. TrueAlarm Multi-Sensor (Photoelectric with Thermal): Simplex #4098-9754
1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Thermistor shall be self restoring and rate compensated.
 2. Supply Multi-Sensor Addressable Base Simplex #4098-9792 or Simplex #4098-9794 where Piezo Electric Sounder is specified.
- U. TrueAlarm Multi-Sensor (Photoelectric with Carbon Monoxide): Simplex #4098-9714/9746
1. Shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Electrolytic CO Toxic Gas Sensor.
 2. Supply CO Addressable Base Simplex #4098-9797 or Simplex #4098-9798 where Piezo Electric Sounder is specified.
- V. Air Aspiration Smoke Sensor: Simplex #VLC-600 with 2098-9808 Remote Status LED
1. Laser Detection Chamber type, featuring a high efficiency aspirator continually sampling air through a filtered transport system.
 2. The Housing shall be compact in size measuring 8-7/8" square and enclose the entire TrueAlarm Laser COMPACT sensor.
- W. Duct Smoke Sensor: Simplex #4098-9756 with 2098-9806 Test Station
1. Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.
 2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Mount relay within 3 feet of HVAC control circuit.
 3. Duct Housing shall have a transparent cover to monitor for the presence of smoke and a relay control trouble indicator Yellow LED and Red sensor status LED.
 4. Duct Housing shall include two (2) Test Ports for measuring airflow and for testing. .
 5. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to shutdown associated air handling system.
 6. Each duct detector shall have a Remote Test Station with an alarm LED and test switch located where indicated.
 7. Weatherproof Enclosure if indicated (4098-9845)
- X. Addressable Interface (Monitor) Module; Simplex #4090-9001
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.

2. The monitor module shall mount in a standard single-gang electrical box. Provide mounting bracket and cover plate with LED view port
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. Supply mounting bracket Simplex # 4090-9810 with cover plate with LED light pipe for viewing Simplex # 4090-9807.

Y. Addressable Relay (Control) Module; Simplex # 4090-9002

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. Supply cover plate with LED light pipe for viewing Simplex # 4090-9802

Z. Addressable Multi-Point Module (HVAC Dampers and other); Simplex # 4090-9118

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires. The input shall support the supervised monitoring of normally open, dry contacts in a "T-Sense" configuration.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. Supply cover plate with LED light pipe for viewing Simplex # 4090-9802

AA. Non-Simplex Brand Components – General

1. Under certain circumstances the devices of other Manufacturer's may be required to satisfy environmentally challenging or special applications.
2. Conventional Heat Detection shall be products as manufactured by System Sensor.
3. Weatherproof Conventional Heat Detection shall be products as manufactured by Fire Detection Devices.
4. Linear Heat Detection Cable shall be products as manufactured by Protectowire or SafeCable.
5. Toxic Gas Detection shall be products as manufactured by MSA or Macurco.
6. Photo-Beam Detection shall be products as manufactured by Fire Fighting Enterprises or Xtralis.

7. These system Inputs shall be supervised as Conventional Initiating Device Zones via Panel Module or Addressable Module.
8. Weather Resistant/Proof Signaling shall be products as manufactured by Cooper Notification.
9. NEMA 4X Signaling shall be products as manufactured by MEDC.
10. Aftermarket add-on Relays shall be products as manufactured by Air Products and Controls.

BB. Remote Annunciator Panel; Simplex # 4100-940X

1. Supervised remote annunciator with same look and feel as Primary Control Display including audible and visual indication of fire alarm by device, and audible and visual indication of system trouble.
2. Multi-line expanded content 320x240 dot matrix (QVGA) active event display screen with Bright white LED backlighting capable of displaying up to 854 characters.
3. English display: Indicates system normal with date and time during normal operation. Indicates type of alarm or trouble exact device with location, number of alarms with scrolling capability and supervisory conditions.
4. Six dedicated LED indicators: Power on, Alarm silence, System trouble, System supervisory, and Two alarm LED's.
5. Password protected.
6. LCD/lamp test button.
7. Control buttons: Alarm acknowledge, Supervisory acknowledge, Trouble acknowledge, Alarm silence. System reset, Scrolling next and previous, Seven programmable buttons for customized usage.
8. Mounting: Factory mounted in surface wall-mounted cabinet enclosure with key access. Simplex Red finish.

CC. Small Form Voice Command Remote Annunciator Panel; Simplex # 4100-940X

1. Supervised remote annunciator with same look and feel as Primary Control Display including audible and visual indication of fire alarm by device, and audible and visual indication of system trouble.
2. Multi-line expanded content 320x240 dot matrix (QVGA) active event display screen with Bright white LED backlighting capable of displaying up to 854 characters.
3. English display: Indicates system normal with date and time during normal operation. Indicates type of alarm or trouble exact device with location, number of alarms with scrolling capability and supervisory conditions.
4. Six dedicated LED indicators: Power on, Alarm silence, System trouble, System supervisory, and Two alarm LED's.
5. Password protected.
6. LCD/lamp test button.
7. Control buttons: Alarm acknowledge, Supervisory acknowledge, Trouble acknowledge, Alarm silence. System reset, Scrolling next and previous, Seven programmable buttons for customized usage.
8. Cabinet Mounted Remote Microphone 4003-9803

9. Mounting: Mounted in surface/semi-flush wall-mounted cabinet (YM0356) enclosure with key access. Enclosure access door shall deliver with painted label FIRE ALARM EMERGENCY COMMUNICATION SYSTEM LOCAL OPERATING CONSOLE. Simplex Red finish with white lettering.

DD. System Expansion Transponder; Simplex # 4100-96XX

1. System hardware expansion shall occur collocated or remote of the Fire Alarm Master Controller using only system Transponders based on the same controls and enclosures used by the FACP.
2. System Expansion Transponder shall be Simplex 4100 ES MINIPLEX Type 4100-9600 Series.
3. Expansion Power Supplies shall be 4100 ES Type EPS, SPS, RPS, XPS, or TPS as dictated by the project requirements.
4. System Audio Expansion shall use the same 4100 ES Amplifier type as the Master Controller.

2.3 BATTERIES AND EXTERNAL CHARGER

A. Battery; Simplex # 2081-XXXX

1. Shall be 12 volt, Gel-Cell type.
2. Shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 15 minutes of alarm upon a normal AC power failure.
3. The batteries are to be completely maintenance free.

B. Battery Charger; Simplex# 4081-XXXX

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt source.

C. Enclosure; Simplex# 4081-XXXX

1. Shall be of adequate volume to support external mounting of the battery reserve. Coordinate with supplier for proper selection and supply as necessary.

2.4 SPARE DEVICES; Simplex# BESAFEADDR

- A. Provide the spare devices listed below in addition to all quantity of devices indicated on drawings. Deliver devices to Owner at conclusion of project.

1. One (1) sensor of each type
2. One (1) sensor base of each type
3. One (1) manual pull station of each type

- 4. One (1) interface module
- 5. One (1) control module
- 6. Two (2) speaker-visual devices
- 7. One (1) visual device

- B. Extra material to be stored in a manufacturer approved and supplied spare parts kit. The enclosure shall be of adequate interior volume, be clearly labeled as to contents, and installed by the contractor in a readily accessible location for routine service activities.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NFPA 72, local and state codes, as shown on the drawings, and as recommended by the equipment manufacturer.
- B. Device Mounting: All fire detection and alarm system devices, control panels and remote annunciators shall be installed as follows:
 - 1. Accessible ceilings (lay-in ceilings or suspended drywall or similar construction)
 - a. flush mounted devices with recessed box and concealed wiring/conduit
 - 2. Inaccessible ceilings (exposed 'open' structure or inaccessible ceilings)
 - a. unfinished spaces; surface mounted devices using exposed conduit and boxes
 - b. finished spaces; surface mounted devices using surface raceway
 - 3. Hollow walls (stud walls or hollow CMU)
 - a. flush mounted devices with recessed box and concealed wiring in conduit
 - b. surface devices with exposed conduit may be used only in unfinished spaces (mechanical / electrical rooms or similar areas).
 - 4. Solid walls (solid masonry)
 - a. surface mounted devices with surface raceway system
 - 1) exposed conduit may be used only in unfinished spaces (mechanical / electrical rooms or similar areas).

3.2 WIRING METHODS

- A. General: All fire alarm system wiring shall be installed concealed wherever possible.
 - 1. Install wiring in cable tray where indicated. Use an approved cable support system attached directly to structure elsewhere.
 - 2. No wiring shall lie directly on ceilings. No wiring shall be strapped or tied to piping, ductwork or conduits.
 - 3. In open structure areas (rooms without ceilings) install wiring in conduit.
- B. Conduit and Raceway:
 - 1. Conduit shall be electrical metallic tubing, 3/4" minimum, with fittings and boxes.

2. All conduit and junction boxes shall be concealed in finished areas and may be exposed in unfinished areas or areas without ceilings.
3. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer
4. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
5. All conduit, mounting boxes, junction boxes and panels are to be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.
6. Fire alarm cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
7. Conduit sleeves with fire-stopping shall be provided where open wiring penetrates floors or fire-rated partitions.

C. Wiring:

1. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system.
2. All fire alarm system wiring and cables must be new and be color-coded red
3. Number and size of conductors or cables shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and signaling line circuits, and 14 AWG for notification appliance circuits.
4. Wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
5. Wire and cable not installed in conduit shall have a plenum-rated fire resistance rating as indicated in NFPA 70 (e.g., FPLR).
6. Conductors in conduit shall be type THHN or THWN insulated as specified in other Section 260519,
7. Wire and Cable shall be as recommended by the equipment manufacturer and approved for use as a Fire Alarm Cable by the National Fire Code and the local authority. Where exposed all circuits shall be enclosed in EMT or better. Installation shall follow Section 16100.
8. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This panel circuit breaker shall be labeled as FIRE ALARM in "RED" and be provided with a "RED" Circuit Breaker Lock, Garvin UBL2 or equivalent. The control panel shall be grounded using a #10 AWG conductor.
9. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
10. All field wiring shall be electrically supervised for open circuit and ground fault.
11. All conductors and cables shall be installed without the use of splices unless permitted by the manufacturer.
12. Cable lubricants shall be used only as permitted by the manufacturer.

13. Flexible connectors are to be used for all devices mounted in suspended lay-in ceiling panels.
14. No wiring other than fire alarm detection, alarm or auxiliary functions will be permitted in fire alarm raceways.

D. Terminal Boxes, Junction Boxes and Cabinets

1. All boxes and cabinets shall be factory painted red and UL listed for their use and purpose. Suppliers of such material include Arlington Industries, Bridgeport, Garvin, and Space Age Electronics.

E. The contractor shall supply two Category VI Cables between the customer's primary network service switch and the FACP to support IP Based Remote Service Monitoring and Reporting. Cables shall be certified to meet the ANSI/TIA -568-B.2-1 Standard for Gigabit Ethernet. Only 22 or 23 AWG copper shall be allowed.

3.3 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Equipment Mounting: Install fire-alarm control unit on utility strut to provide an air-space from the wall surface if mounting on an exterior masonry wall.

1. Install seismic bracing. Comply with requirements of "Vibration and Seismic Controls for Electrical Systems."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (460-mm) centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Equipment Mounting: Install fire-alarm control unit on finished floor.

1. Comply with requirements for seismic-restraint devices specified in "Vibration and Seismic Controls for Electrical Systems."

D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in "Vibration and Seismic Controls for Electrical Systems."
- E. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
 2. Mount manual fire-alarm box on a background of a contrasting color.
 3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- F. Smoke-or-Heat Detector Spacing:
1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing shall not exceed 30 foot spacing.
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- G. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
 2. Duct Smoke Detector shall be equipped with Remote Test Switches. Test Switches shall be installed in the ceiling below the Roof Top Unit they support if applicable.
- I. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.
- J. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in elevator shafts, unless the shaft is protected by an Automatic Sprinkler System installed in accordance with NFPA 13.
- K. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

- L. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- M. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes. Install all devices at the same height unless otherwise indicated.
- N. Visible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install such that the center line of the Visible Alarm Device is 80" above the finished floor surface. Install all devices at the same height unless otherwise indicated
- O. Alarm Network Communications:
 - 1. Digital Alarm Communicator and TCP/IP communications cable as specified in 2.3 J. 2. & 4. shall be Category 6 Plenum Rated Type. Cables shall be certified to meet the ANSI/TIA - 568-B.2-1 Standard for Gigabit Ethernet. Only 22 or 23 AWG copper shall be allowed. Work shall be completed in conformance with accepted Voice and Data installation practices.
- P. Identification:
 - 1. All wiring shall be identified at the FACP and at each terminal and junction box. Each conductor and cabinet terminal must be numbered and coded. All conductors in conduit pull boxes or cabinets containing more than one wire must be labeled on each end with machine printed on flexible high adhesion vinyl tape.
 - 2. Wiring color codes must be used throughout. Transposing or changing color coding of wires will not be permitted. .
 - 3. Junction boxes shall be painted fire red and identified with 'FA' on cover. Suppliers of such material include Arlington Industries, Bridgeport, Garvin, and Space Age Electronics.
- Q. Smoke detectors and pull stations shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect devices from contamination and physical damage

3.4 COORDINATION

- A. Coordinate with all other trades in submittal of shop drawings. Shop drawings shall detail space conditions to the satisfaction of all concerned trades, subject to final review by the architect or project manager whichever is applicable. If installation of equipment, raceways, cable trays and/or conduit is performed prior to coordination with other trades, which interferes with work of other trades, make necessary changes to correct the condition at no additional cost to the owner.
- B. Maintain all existing equipment and systems in operation until new equipment and systems are installed, tested and made operational as required, to follow phasing of construction.
- C. Coordinate and disconnect existing electronic/electrical equipment, services and/or controls to items being removed.

3.5 TEST

- A. Provide the service of a competent, factory-trained project manager NICET Level IV and technician NICET Level II minimum authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
 - 3. Verify activation of all flow switches.
 - 4. Open and ground initiating device and signaling line circuits and verify that the trouble signal actuates.
 - 5. Check presence and audibility of tone and voice message at all alarm notification devices.
 - 6. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.
 - 7. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
 - 8. Test optional features based on the manufacturer's instructions.
- B. After certification of completion and operation of the system, the entire system shall be retested by the manufacturer's representative in the presence of a representative of the owner and the Authority Having Jurisdiction, and a test report per NFPA 72, shall be made out, in triplicate, and signed by the owner's representative, indicating that they witnessed the actual test of the system.

3.6 FINAL INSPECTION

- A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.7 INSTRUCTIONS

- A. Furnish the services of a Simplex field representative who shall have specialized experience in the operation and maintenance of the systems and shall instruct the owner's personnel in the techniques involved in the operation of the systems.
- B. Formal on-site training shall be provided to the owner's representative/maintenance personnel and shall include instructions in the location, inspection, maintenance, testing and operation of all electronic components.
- C. Provide minimum of (4) hours of general instruction. Provide a signed copy of the name of the personnel giving the instructions and the personnel of the owner who were instructed.

END OF SECTION 283100